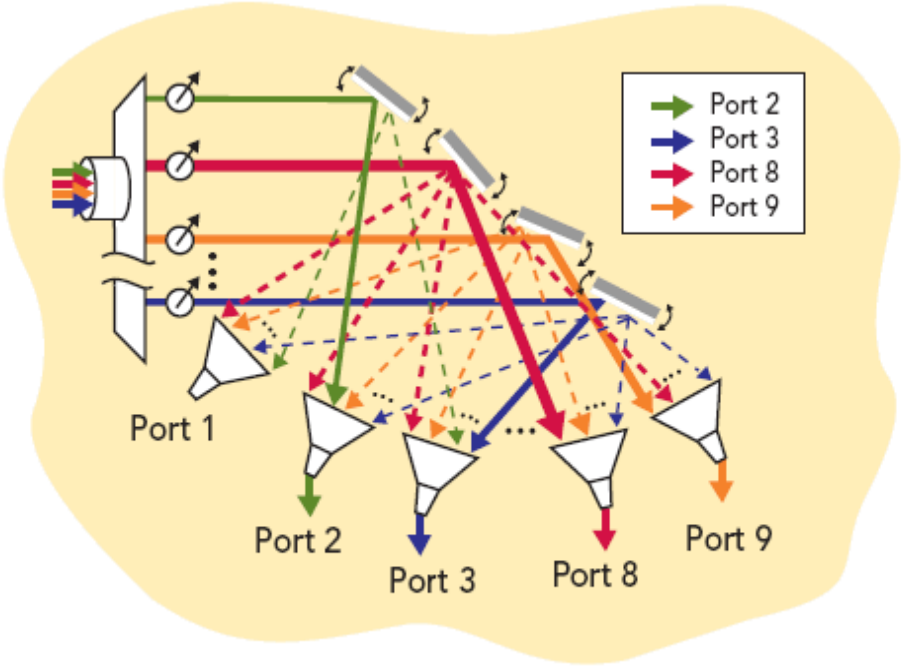
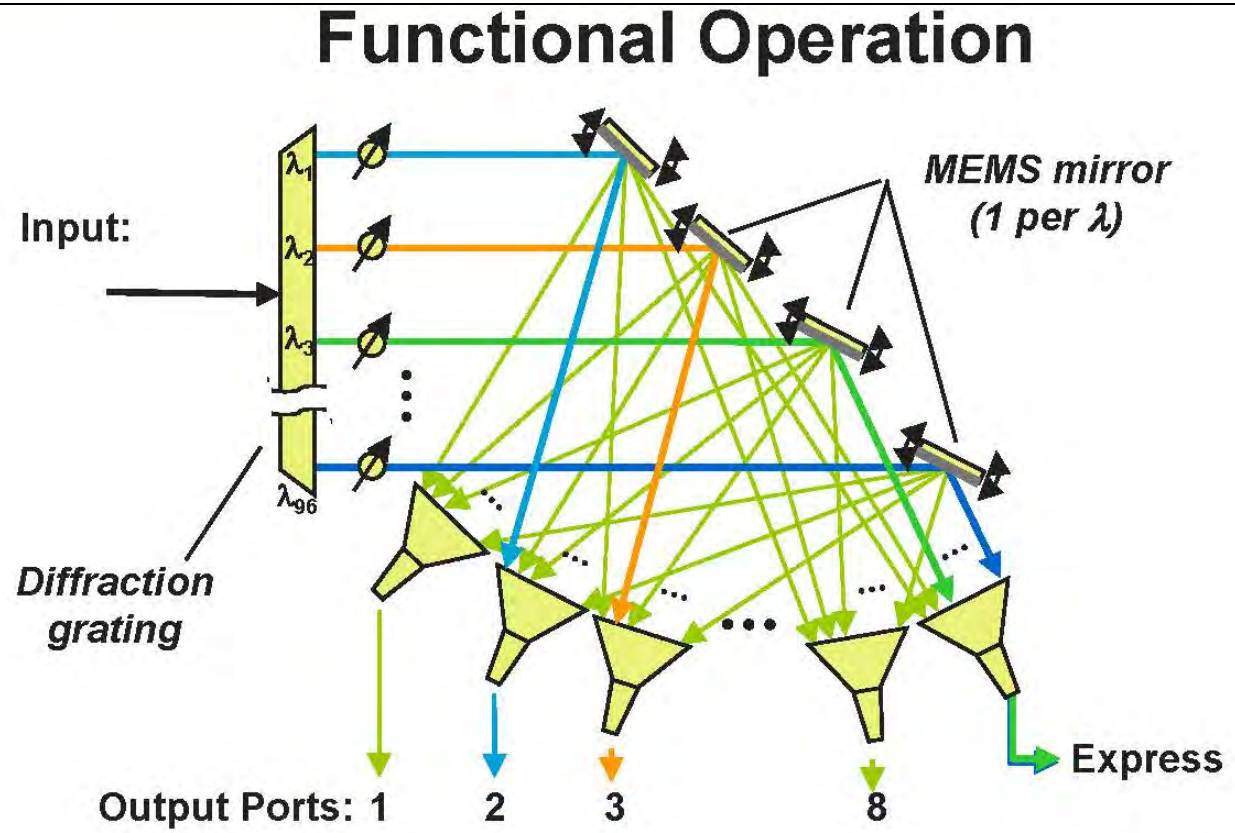
EXHIBIT K

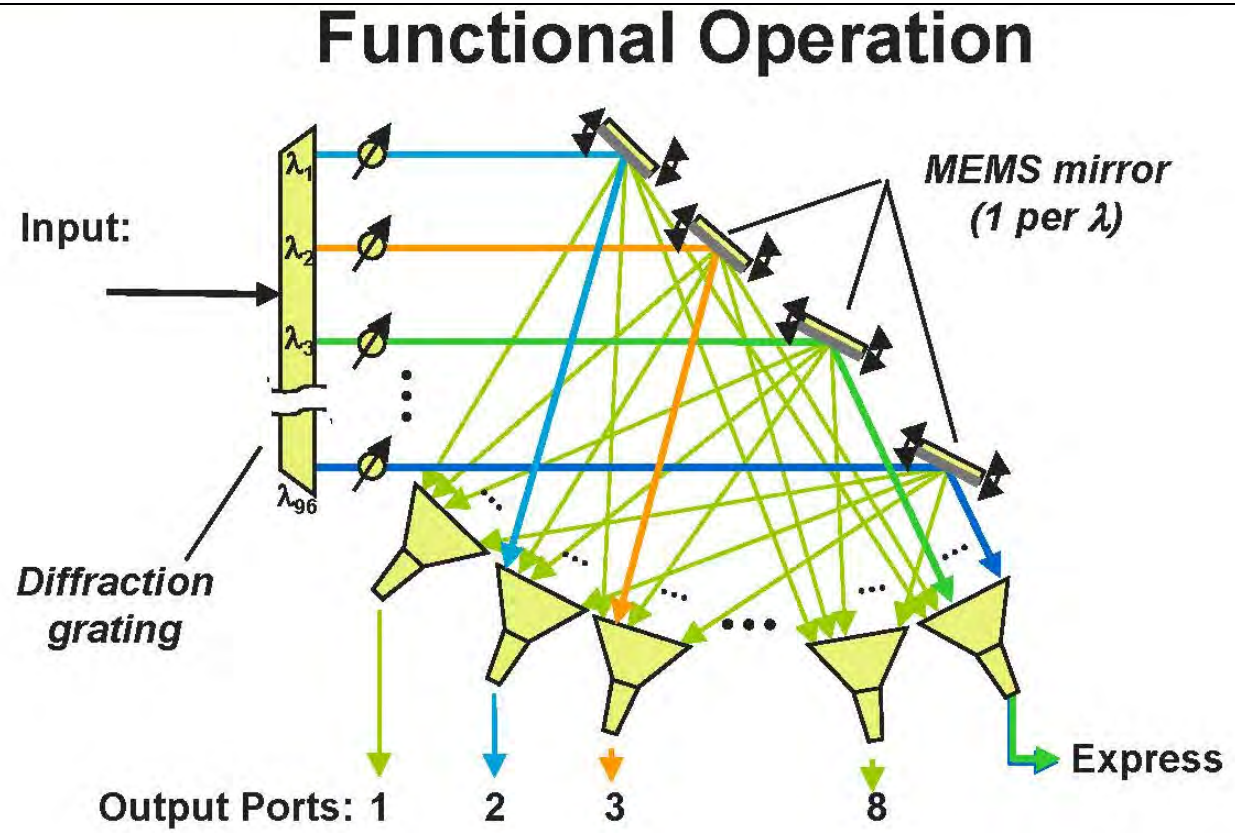
Claims 7, 8 and 13 of U.S. Patent No. RE42,368
v.
Ciena Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

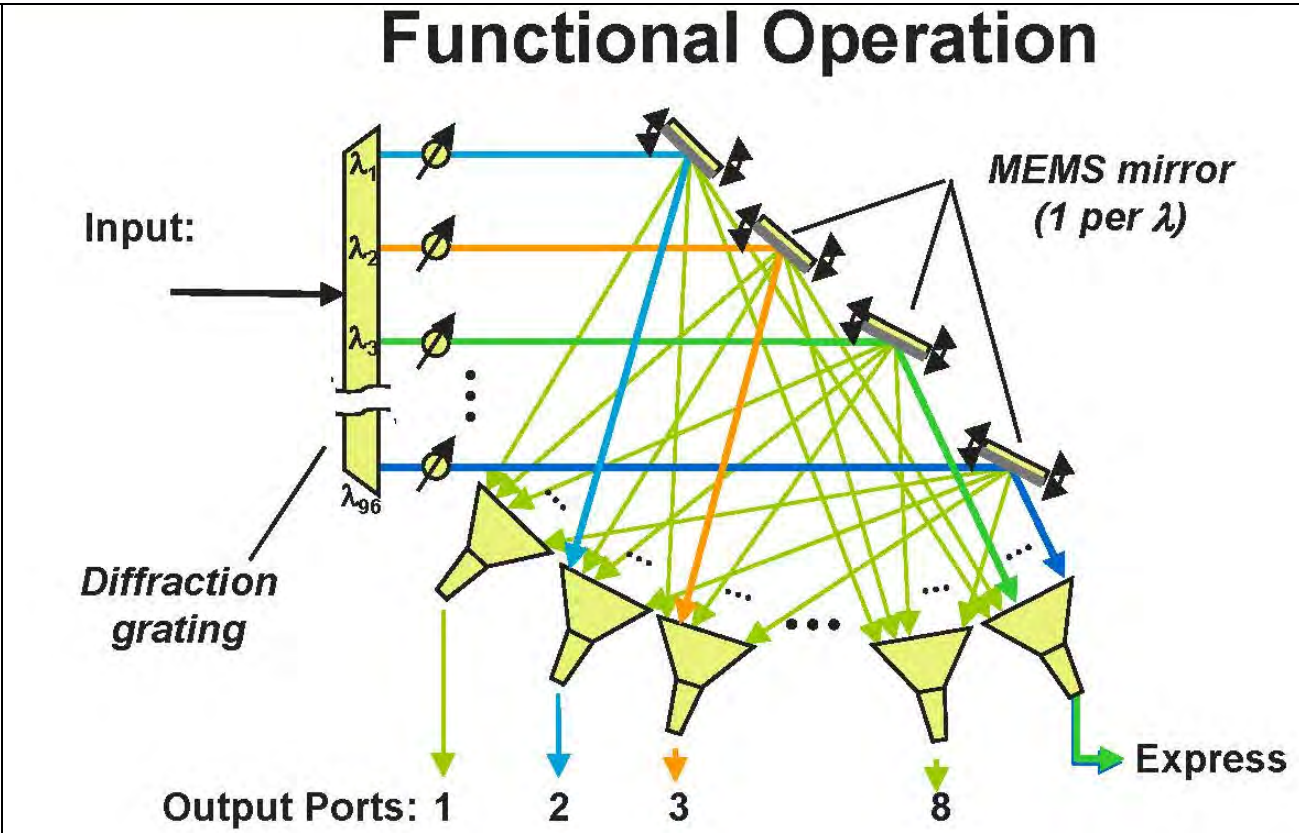
Claim	Product Analysis
1. An optical add-drop apparatus comprising:	Ciena makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Ciena's ROADM products, including: • "Special Interoperability Test Certification of Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0 Optical Transport System" from the Joint Interoperability Test Command at the Defense Information Systems Agency, dated February 11, 2010 ("ROADM Test Certification"); • "Module Description and Specifications Manual Software Release 8.1" from Ciena regarding Ciena's 4200 Advanced Services Platform, dated January 2013 ("ROADM Specification"); • "Advances in Optical Networking – Focus on Research Networks" by Jeff Verrant, a Senior Systems Engineer at Ciena Government Solutions, Inc. ("ROADM Powerpoint"); • "4200 ROADM, DWR, OCM and Amplifiers for the 4200 RS 17-slot Advanced Services Platform," which is a datasheet about the 4200 ROADM from Ciena dated 2011 9 ("ROADM Datasheet"); and • information and documents available from Ciena's website (www.ciena.com) ("Website"). According to Ciena's ROADM Datasheet: "A ROADM architecture enables networks to maximize available system bandwidth by adding dynamic reconfigurability at the individual wavelength level, ideal for network applications in which wavelength planning is difficult due to uncertain traffic projections. As a result, changes in the network can happen on demand without affecting other wavelengths and services. "The nine-port, Wavelength Selectable Switch (WSS)-based DWR module performs the primary multi-degree optical switching functionality at each ROADM node. Each DWR module contains a WSS capable

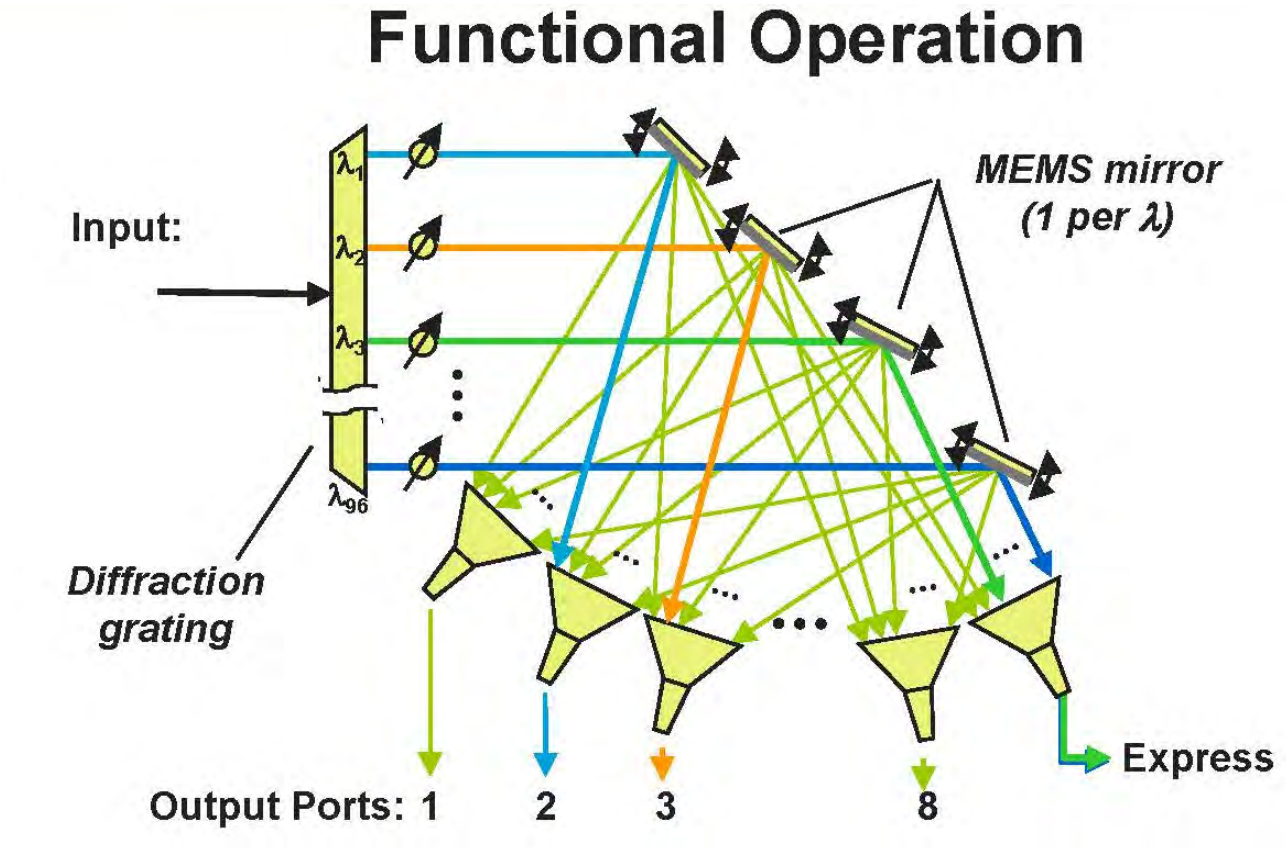
	of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously. "The DWR module also incorporates a passive wavelength combiner that can add or multiplex optical signals from up to nine tributary ports into an aggregate signal. "Network reconfiguration using the DWR module allows flexible, remote provisioning of any demand, and simplifies network planning by safeguarding upgrade capacity and extending network life—resulting in operational and capital savings and faster revenue capture. "In addition to remotely provisioned Add/Drop routing, 4200 ROADM supports automatic optical power control, which automatically adjusts optical power levels for add/drop and express traffic. To achieve power equalization across all wavelengths, each ROADM node requires one OCM module (OCM-8) to monitor the optical power levels of up to 44 different wavelengths on eight inputs." According to Ciena's Website, its ROADM Products offer the following features: • "Expands degree capacity and express or add/drop traffic in-service, with single wavelength granularity • Routes any optical channel or combination of channels to any port, with per-channel attenuation on all channels • Combines optical and electrical technologies for ultimate flexibility • Routes wavelength services from 155 Mb/s to 10 Gb/s anywhere on the network • Optimizes wavelength utilization for sub-wavelength services • Adds/drops 10 and 40G wavelengths to eight degrees through dynamic optical routing • Delivers on-demand highbandwidth services, any port to any port • Controls optical power levels automatically" According to Ciena's Website, the DWR Module includes a WSS that operates as shown in the following figure:

	 DWR building block: WSS : (www.ciena.com/products/4200-ROADM/tab/features/)
an input port for an input multi-wavelength optical signal having first spectral channels;	Ciena's ROADMs include an input port for an input multi-wavelength optical signal having first spectral channels. As shown in Ciena's ROADM Powerpoint, Ciena's ROADM includes an input port for an input multi-wavelength optical signal having first spectral channels as follows:

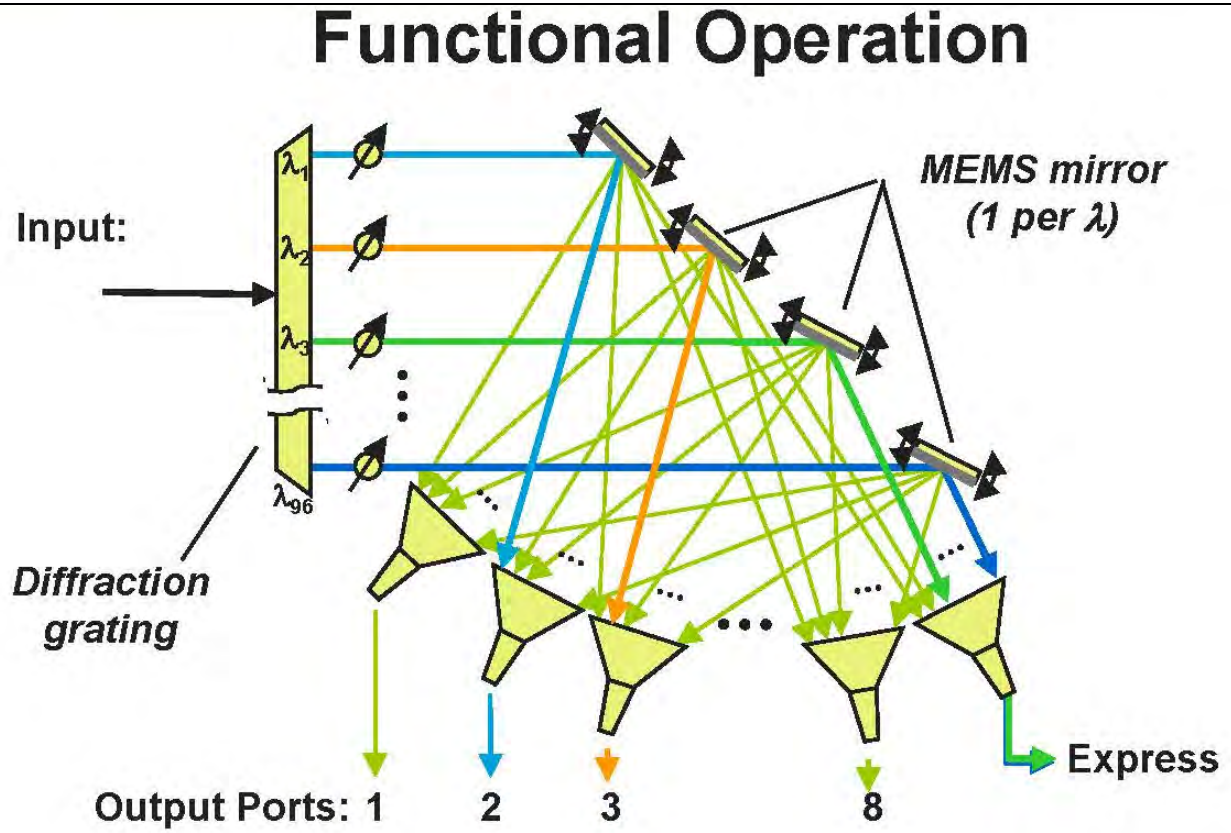
	 (Ciena ROADM Powerpoint, slide 31.)
one or more other ports for second spectral channels;	Ciena's ROADMs include one or more other ports for second spectral channels. As shown in Ciena's ROADM Powerpoint, Ciena's ROADMs include a WSS-based DWR module. The DWR module includes one or more other ports for second spectral channels as follows:

	 (Ciena ROADM Powerpoint, slide 31.)
an output port for an output multi-wavelength optical signal;	Ciena's ROADMs include an output port for an output multi-wavelength optical signal. Ciena's ROADM Powerpoint includes a figure that depicts how Ciena's ROADM includes an output port for an output multi-wavelength optical signal. The "Express" output port receives more than one wavelength or spectral channel, thereby providing an output port for an output multi-wavelength optical signal as follows:

	 (Ciena ROADM Powerpoint, slide 31.)
a wavelength-selective device for spatially separating said spectral channels;	The Ciena ROADMs include a wavelength-selective device for spatially separating said spectral channels. According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module. The DWR module includes a wavelength-selective device for spatially separating said spectral channels. As shown in Ciena's ROADM Powerpoint, its ROADMs include a WSS-based DWR module. The DWR module includes a diffraction grating, which is a wavelength-selective device, as follows:

	 (Ciena ROADM Powerpoint, slide 31.)
a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements	The Ciena ROADMs include a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module. The DWR module includes a spatial array of beam-deflecting

being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.	elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. As shown in the below figure from Ciena's ROADM Powerpoint, the WSS-based DWR module in its ROADM includes MEMs mirrors, each of which receives one wavelength (or spectral channel). The MEMs mirrors are beam-deflecting elements. The MEMs mirrors are individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port as follows:

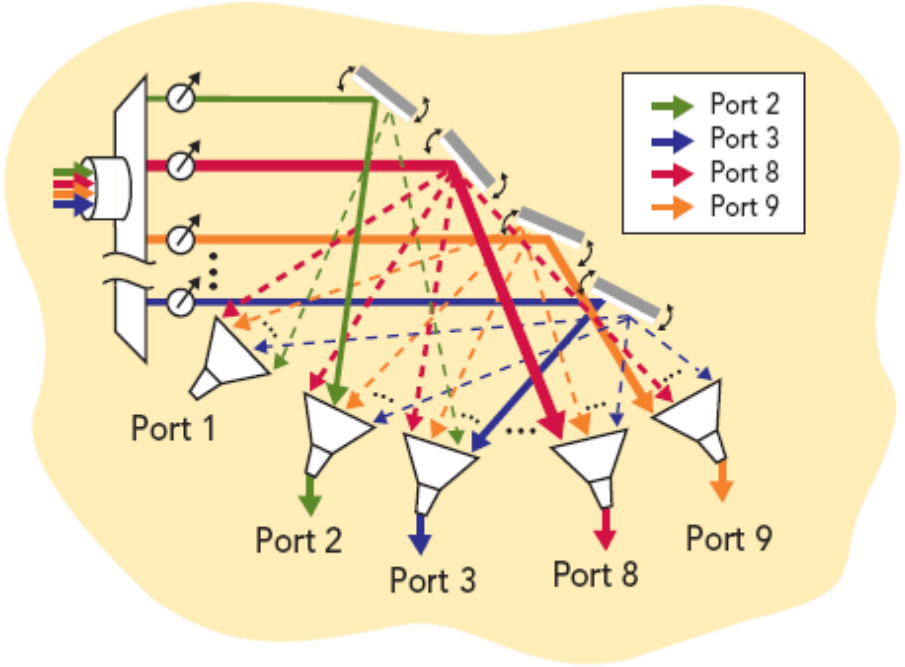
	 (Ciena ROADM Powerpoint, slide 31.) According to Ciena's Website, ROADM Specification, and ROADM Datasheet, Ciena's "ROADM supports automatic optical power control, which automatically adjusts optical power levels for add/drop and express traffic."
7. The optical add-drop apparatus of claim 1 further comprising alignment mirrors for	The Ciena ROADMs described in claim 1 further include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.

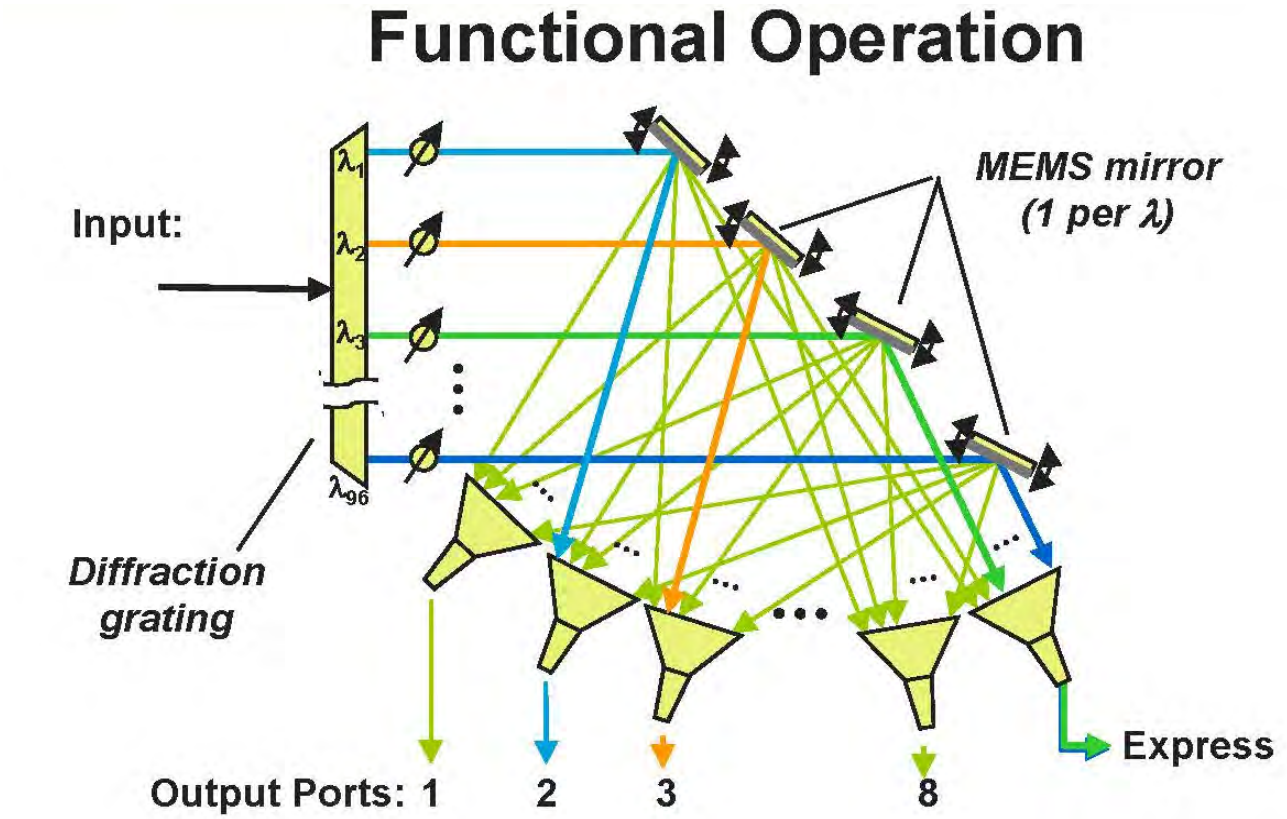
adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.	As discussed above, Ciena ROADMs use at least a MEMs WSS. The WSS include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.
8. The optical add-drop apparatus of claim 7 further comprising collimators associated with said alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.	The ROADMs described in claim 7 further comprise collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators. Ciena ROADMs use at least a MEMs WSS. The WSS include collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.
13. The optical add-drop apparatus of claim 1, wherein said beam-deflecting elements comprise micromachined mirrors.	The beam deflecting elements of the ROADMs described in claim 1 comprise micromachined mirrors. Ciena ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include micromachined mirrors. Ciena represents in interrogatory responses that its ROADMs also include WSS devices from Finisar. Those devices include LCoS beam-deflecting elements that comprise micromachined mirrors.

Claim 12 of U.S. Patent No. RE42,678
v.
Ciena Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

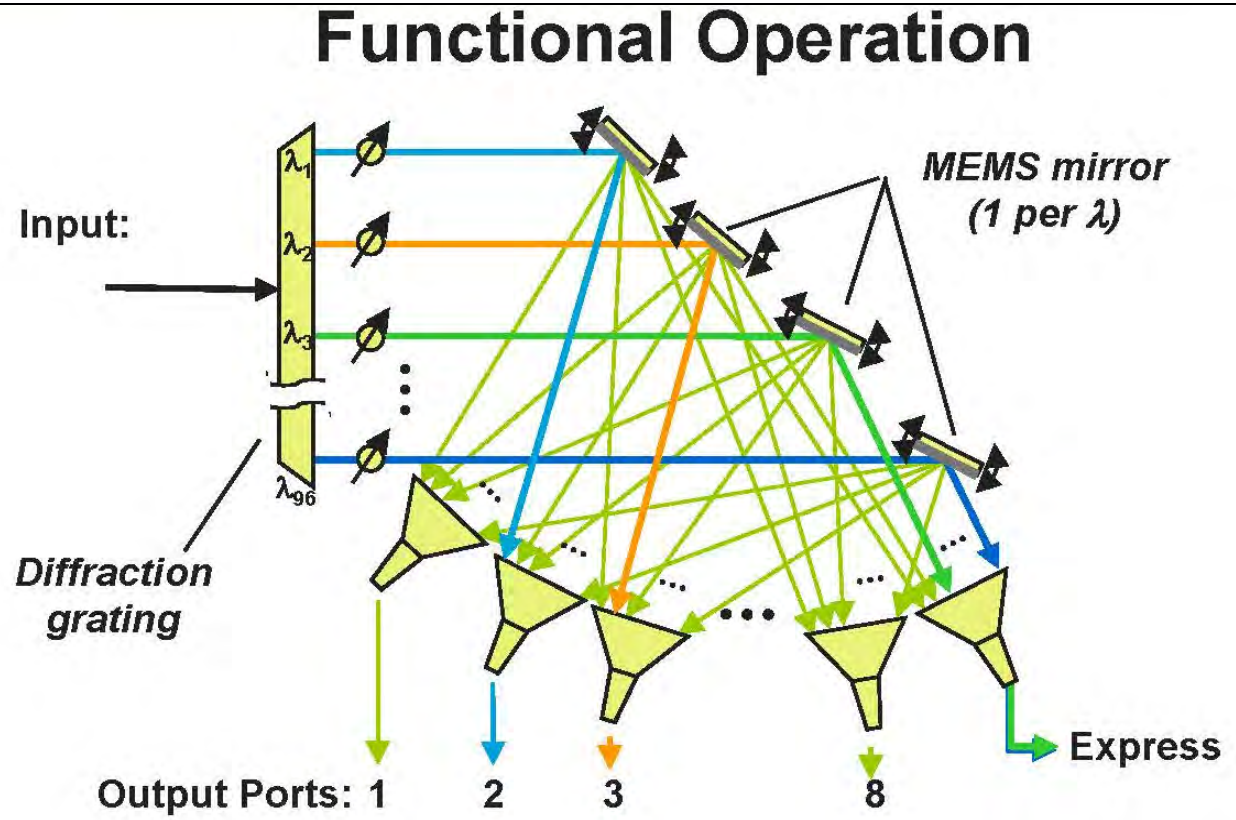
Claim	Product Analysis
1. A wavelength-separating-routing apparatus, comprising:	Ciena makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Ciena's ROADM products, including: • "Special Interoperability Test Certification of Ciena ActivSpan CN 4200 RS FlexSelect Advanced Services Platform with Software Release 7.2.0 Optical Transport System" from the Joint Interoperability Test Command at the Defense Information Systems Agency, dated February 11, 2010 ("ROADM Test Certification"); • "Module Description and Specifications Manual Software Release 8.1" from Ciena regarding Ciena's 4200 Advanced Services Platform, dated January 2013 ("ROADM Specification"); • "Advances in Optical Networking – Focus on Research Networks" by Jeff Verrant, a Senior Systems Engineer at Ciena Government Solutions, Inc. ("ROADM Powerpoint"); • "4200 ROADM, DWR, OCM and Amplifiers for the 4200 RS 17-slot Advanced Services Platform," which is a datasheet about the 4200 ROADM from Ciena dated 2011 9 ("ROADM Datasheet"); and • information and documents available from Ciena's website (www.ciena.com) ("Website"). According to Ciena's ROADM Datasheet: "A ROADM architecture enables networks to maximize available system bandwidth by adding dynamic reconfigurability at the individual wavelength level, ideal for network applications in which wavelength planning is difficult due to uncertain traffic projections. As a result, changes in the network can happen on demand without affecting other wavelengths and services. "The nine-port, Wavelength Selectable Switch (WSS)-based DWR module performs the primary multi-degree optical switching functionality at each ROADM node. Each DWR module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination,

	and can support 10G and 40G wavelengths simultaneously. "The DWR module also incorporates a passive wavelength combiner that can add or multiplex optical signals from up to nine tributary ports into an aggregate signal. "Network reconfiguration using the DWR module allows flexible, remote provisioning of any demand, and simplifies network planning by safeguarding upgrade capacity and extending network life—resulting in operational and capital savings and faster revenue capture. "In addition to remotely provisioned Add/Drop routing, 4200 ROADM supports automatic optical power control, which automatically adjusts optical power levels for add/drop and express traffic. To achieve power equalization across all wavelengths, each ROADM node requires one OCM module (OCM-8) to monitor the optical power levels of up to 44 different wavelengths on eight inputs." According to Ciena's Website, its ROADM Products offer the following features: • "Expands degree capacity and express or add/drop traffic in-service, with single wavelength granularity • Routes any optical channel or combination of channels to any port, with per-channel attenuation on all channels • Combines optical and electrical technologies for ultimate flexibility • Routes wavelength services from 155 Mb/s to 10 Gb/s anywhere on the network • Optimizes wavelength utilization for sub-wavelength services • Adds/drops 10 and 40G wavelengths to eight degrees through dynamic optical routing • Delivers on-demand highbandwidth services, any port to any port • Controls optical power levels automatically" According to Ciena's Website, the DWR Module includes a WSS that operates as shown in the following figure:

	 DWR building block: WSS : (www.ciena.com/products/4200-ROADM/tab/features/)
a) multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports;	The Ciena ROADMs include multiple fiber collimators, providing an input port for a multi -wavelength optical signal and a plurality of output ports. According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module ("DWR module"). The DWR module includes multiple fiber collimators, providing an input for multi-wavelength optical signal and a plurality of output ports.
b) a wavelength-separator, for separating said multi-wavelength optical signal from said input port	The Ciena ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels.

into multiple spectral channels;	According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module. The DWR module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. As shown in Ciena's ROADM Powerpoint, the DWR module includes a diffraction grating, which is a wavelength separator, as follows:  (Ciena ROADM Powerpoint, slide 31.)
c) a beam-focuser, for focusing	The Ciena ROADMs include a beam-focuser, for focusing said spectral channels into corresponding spectral

said spectral channels into corresponding spectral spots; and	spots. According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module. The DWR module includes a beam-focuser, for focusing said spectral channels into corresponding spectral spots.
d) a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports.	The Ciena ROADMs include a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Ciena's ROADM Datasheet, ROADM Specification, and Website, Ciena's ROADM products include a WSS-based DWR module. The DWR module includes a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. As shown in the below figure from Ciena's ROADM Powerpoint, the micromirrors are being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports as follows:

	 (Ciena ROADM Powerpoint, slide 31.) According to Ciena's Website, ROADM Specification, and ROADM Datasheet, Ciena's "ROADM supports automatic optical power control, which automatically adjusts optical power levels for add/drop and express traffic."
12. The wavelength-separating-routing apparatus of claim 1 wherein each channel micro-	The channel micromirrors of the ROADMs described in claim 1 are silicon micromachined mirrors. Ciena ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include silicon

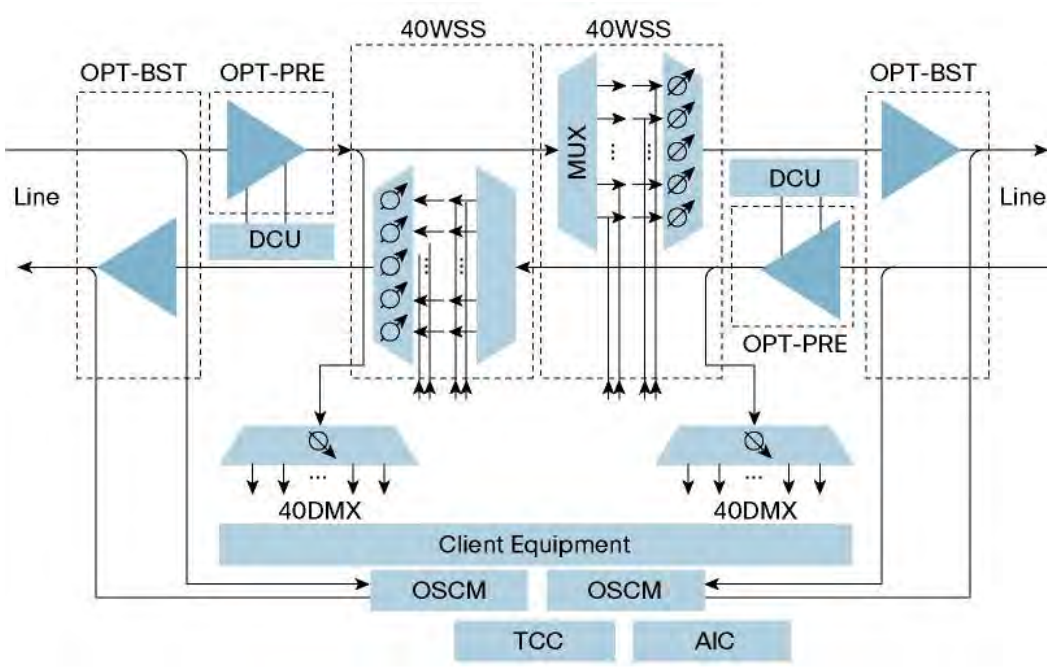
mirror is a silicon micromachined mirror.	micromachined mirrors. Ciena represents in interrogatory responses that its ROADMs also include WSS devices from Finisar. Those devices include LCoS beam-deflecting elements that comprise silicon micromachined mirrors.

Claims 7, 8 and 13 of U.S. Patent No. RE42,368
v.
Cisco Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Devices

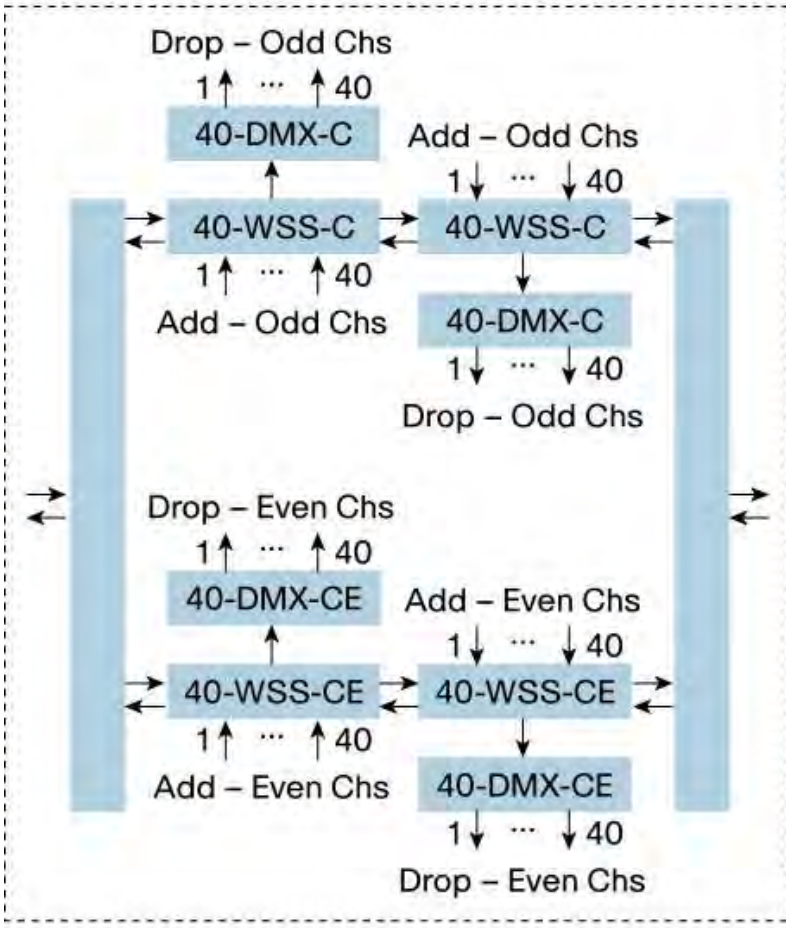
Claim	Product Analysis
1. An optical add-drop apparatus comprising:	Cisco makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Cisco makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Cisco's ROADM products, including: • "Data Sheet: 40-Channel Reconfigurable Optical Add/Drop Multiplexing Portfolio for the Cisco ONS 15454 Multiservice Transport Platform," dated 1992-2007 ("ONS 15454 Data Sheet"); • "Data Sheet: Cisco NCS 2000 Service Line Cards," dated 2013 ("NCS 2000 Data Sheet 1"); • "Data Sheet: Cisco Network Convergence System 2000 ROADM and Amplifier Line Cards," dated 2013 ("NCS 2000 Data Sheet 2"); • "Cisco ONS 15200 Series DWDM Systems," from Cisco's website (www.cisco.com/c/en/us/products/optical-networking/ons-15200-series-dwdm-systems/index.html) ("ONS 15200 Webpage"); • "Data Sheet: Cisco ONS 15216 C L-Band Splitter/Combiner Module for Cisco ONS 15454 MSTP" dated 1992-2005 ("ONS 15200 Data Sheet"); • "Cisco NCS 2002 and NCS 2006 Line Card Configuration Guide, Release 10.x.x," chapter titled "Provisioning Reconfigurable Optical Add/Drop Cards," which "describes the line cards deployed in reconfigurable optical add/drop (ROADM) networks," pp12-16, which focus on the "40-WSS-C and 40-WSS-CE Card," and pp 31-38, which focus on "Single Module ROADM (SMR-C) Cards" ("ROADM Configuration Chapter"); and • information and documents available from Cisco's website (www.cisco.com) ("Website").

	According to Cisco's ONS 15454 Data Sheet: "The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) (Figure 1) provides a comprehensive, intelligent dense wavelength-division multiplexing (DWDM) solution for expanding metropolitan (metro) and regional bandwidth." Figure 1 is labeled as "40-Channel Wavelength Cross-Connect (40-WXC), Wavelength Selective Switch (40-WSS), Multiplexer (40-MUX), and Demultiplexer (40-DMX) Units." "While Wavelength Selective Switch (WSS) units provide degree-2 type reconfigurability (drop wavelength in a node vs. let it pass through the node), an ROADM node based on 40-WXC units can support up to degree-8 reconfigurability. This means that for each wavelength it is possible to decide if it has to be locally dropped or routed to any of the other 7 pass-through directions of the node. Such a capability not only enhances the flexibility of the DWDM transport network but also dramatically reduces the need for costly transponders to perform optical-to-electrical-to-optical conversion (typically 2 transponders/crossponders per add/drop channel or wavelength)." "As even in complex mesh network topologies it is likely that degree-2 reconfigurability would be enough for most of the node, the 40-channel ROADM portfolio includes also two different versions of the 40-WSS units, one operating on the odd channels of the C band spectrum (40-WSS-C) and the other one operating on the even channels of the C band spectrum (40-WSS-CE). The units can be used in conjunction with existing 32-channel ROADM solutions and with 40-WXC units to provide the greatest degree of flexibility for Cisco ONS 15454 MSTP deployments." "Embedded automatic power control mechanisms feature the possibility to interface with different types of DWDM units without requiring external attenuators. Used in conjunction with the 40-channel Multiplexer and 40-channel Demultiplexer allows to manage local add/drop traffic of the specific direction supported by the 40-WXC unit." "Embedded automatic power control mechanisms feature the possibility to interface with different type of DWDM units without requiring external attenuators." A chart in Cisco's ONS 15454 Data Sheet lists the components within the 40-Channel ROADM Units, including a "40-Channel Wavelength Selective Switch"

The following figure 3 from Cisco's ONS 15454 Data Sheet is a chart of the "MSTP 40-Channel Degree-2 ROADM Node" and shows how wavelength selective switches (labeled "WSS") are integrated within a Cisco's ROADM:



The following figure 4 from Cisco's ONS 15454 Data Sheet is a chart of the "MSTP 80-Channel Degree-2 ROADM Node" and shows how wavelength selective switches (labeled "WSS") are integrated within a Cisco's ROADM and how Cisco's ROADM can add and drop signals:

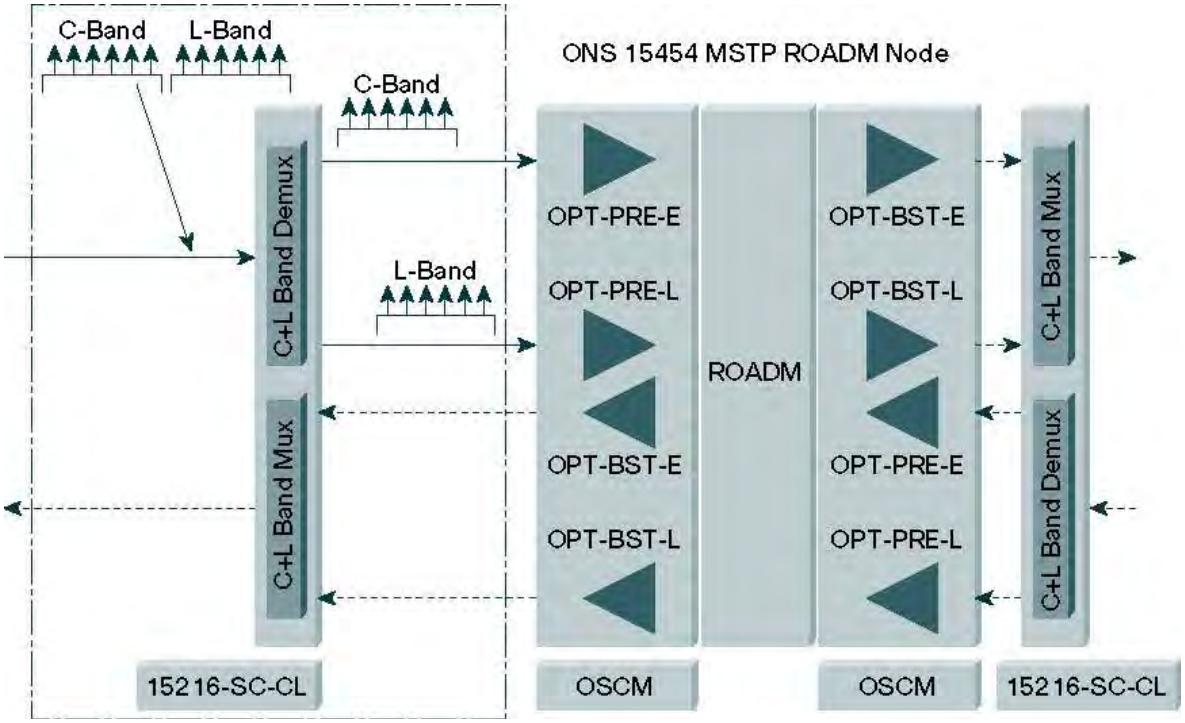


According to Cisco's ONS 15200 Data Sheet and ONS 15200 Webpage, both of which describe the ONS 15200 series of Cisco products, the ONS 15216 is the front end to the WSS ROADM in the ONS 15454. The ONS 15216 and ONS 15454 are integral to one another, so the ONS 15216 cannot work without the ONS 15454 and vice versa.

According to Cisco's ONS 15200 Webpage, "Cisco ONS 15200 Series DWDM Systems consist of

intuitive, compact, passive devices used in a variety of applications. These range from low latency, point-to-point data center interconnect to passive or reconfigurable optical add/drop multiplexer- (ROADM) based metropolitan rings."

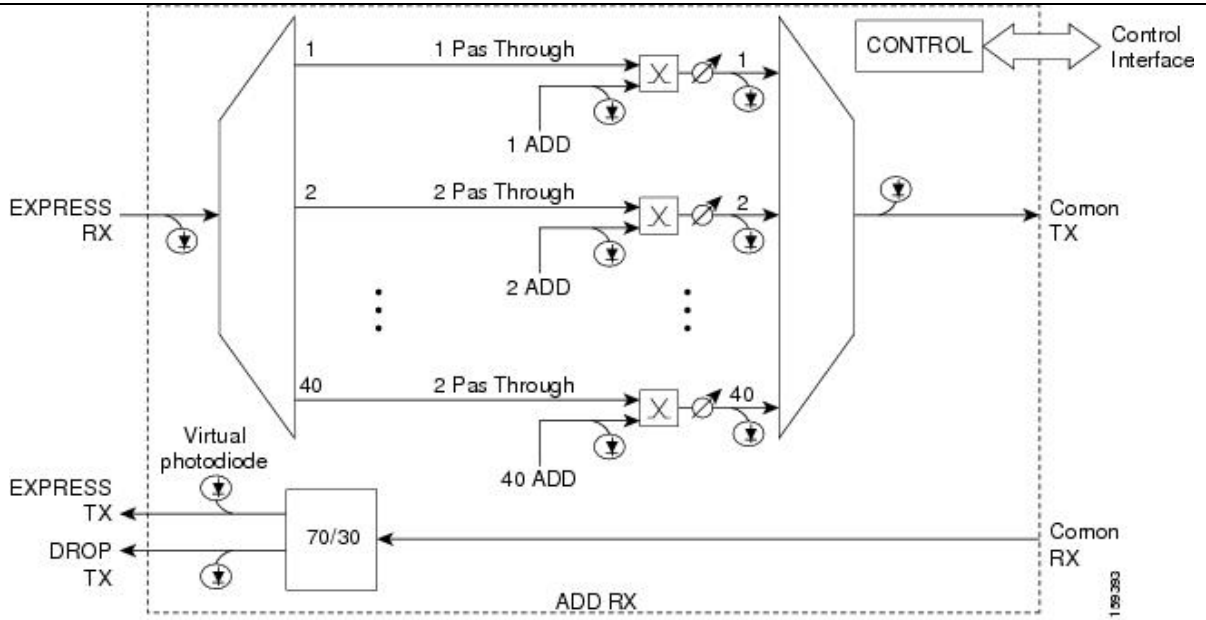
According to Cisco's ONS 15200 Data Sheet, Figure 3 describes "Cisco ONS 15216 C+L-Band Splitter/Combiner Module Deployed in a Cisco ONS 15454 MSTP ROADM Node" and depicts the relationship of Cisco's 15200 series products with Cisco's 15454 ROADM as follows:



According to Cisco's ROADM Configuration Chapter, the Single Module ROADM (SMR-C) Cards are "single-slot 40-channel single module ROADM (SMR-C) cards" and they "integrate the following functional blocks onto a single line card:
"• Optical preamplifier
• Optical booster amplifier

	• Optical service channel (OSC) filter • 2x1 wavelength cross-connect (WXC) or a 4x1 WXC • Optical channel monitor (OCM)" According to Cisco's ROADM Configuration Chapter, the Single Module ROADM (SMR-C) Cards "can manage up to 40 channels spaced at 100GHz on each port." Cisco's ROADM Configuration Chapter about provisioning reconfigurable optical add/drop cards describes the "40-WSS-C and 40-WSS-CE Card" as follows: "The double-slot 40-channel wavelength selective switch C-band (40-WSS-C) or the double-slot 40-channel wavelength selective switch even-channel C-band (40-WSS-CE) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 4: Channel Allocation Plan or Table 5: Channel Allocation Plan) and sends them to dedicated output ports. The 40-WSS-C or 40-WSS-CE card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17 "The 40-WSS-C or 40-WSS-CE features include: • Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction. • Per-channel optical power monitoring using photodiodes. • Signal splitting in a 70%-to-30% ratio, sent to the 40-DMX-C (or 40-DMX-CE) for dropping signals, then to the other 40-WSS-C (or 40-WSS-CE) card. • Aggregate DWDM signal monitoring and control through a variable optical attenuator (VOA). In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available." "Within the 40-WSS-C or 40-WSS-CE card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port." "The 40-WSS-C or 40-WSS-CE has eight types of ports: • ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an

	individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C or 40-WSS-CE card also has one LC-PC-II optical connector for the main input. • COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter. • COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE. • EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C or 40-WSS-CE card in the same NE. • EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C or 40-WSS-CE card within the NE. • DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C(or 40-DMX-CE) card, where the channels are further processed and dropped. “The following figure shows a functional block diagram of the 40-WSS-C or 40-WSS-CE card: Figure 3: 40-WSS-C or 40-WSS-CE Block Diagram:”



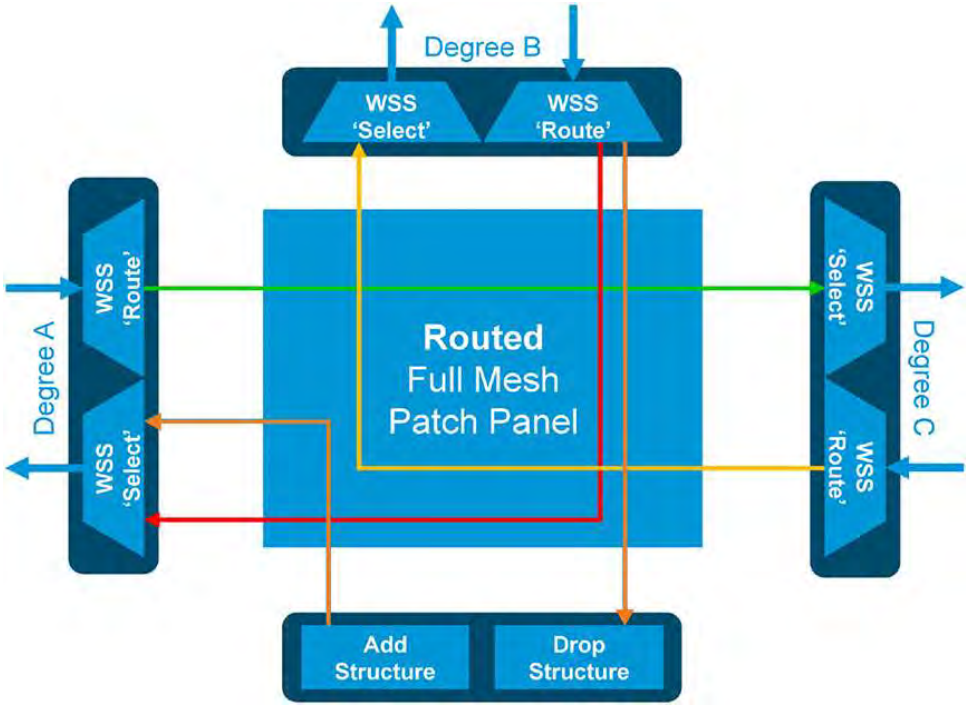
According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide ROADM functionality as follows:

"The 40-WSS-C (or 40-WSS-CE) card works in combination with the 40-DMX-C (or 40-DMX-CE) card to implement ROADM functionality. As a ROADM node, the node can be configured at the optical channel level using CTC, Cisco Transport Planner, and CTM. ROADM functionality using the 40-WSS-C (or 40-WSS-CE) card requires two 40-WSS-C (or 40-WSS-CE) double-slot cards and two 40-DMX-C (or 40-DMX-CE) single-slot cards (for a total of six slots in the chassis)."

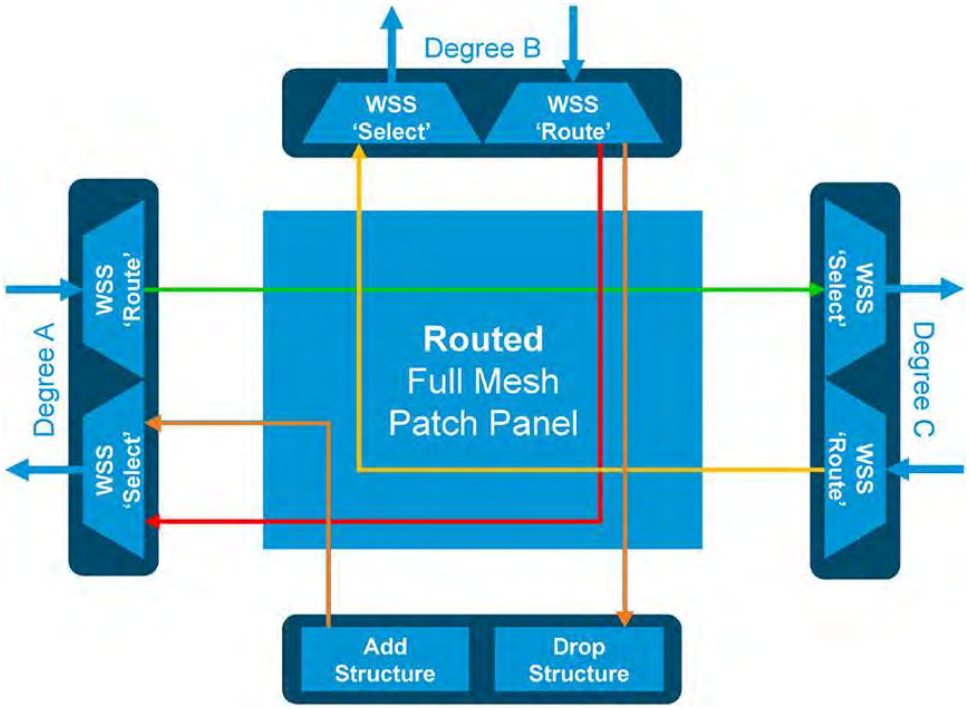
According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide power monitoring functionality as follows:

"The 40-WSS-C (or 40-WSS-CE) has physical diodes that monitor power at various locations on the card. The following table lists the physical diode descriptions."

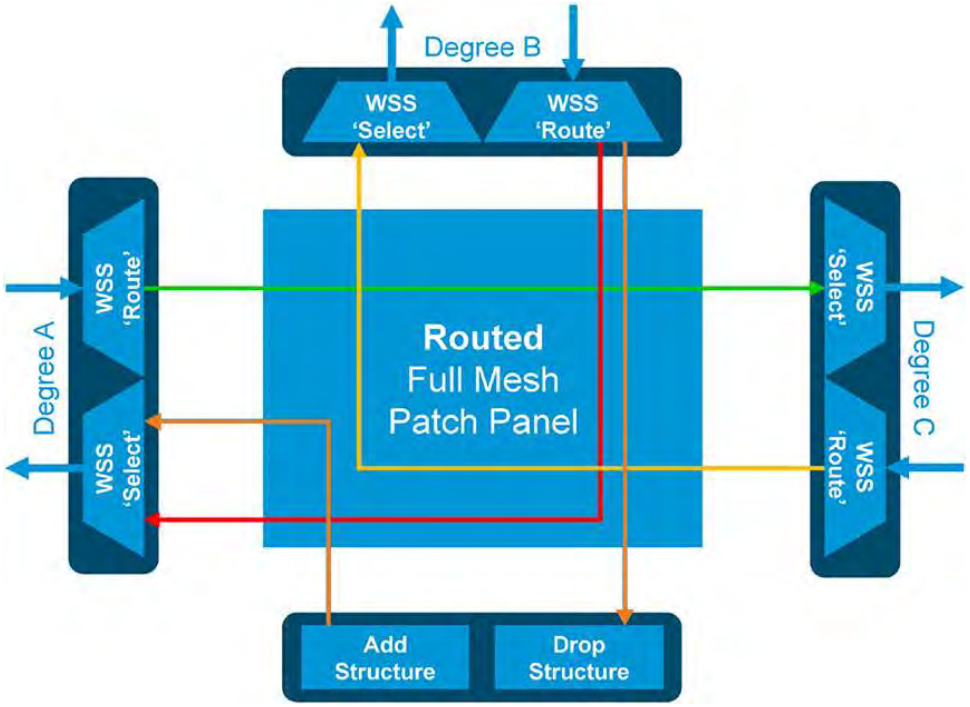
According to Cisco's NCS 2000 Data Sheet 2, Cisco provides a ROADM as follows:

	"The Cisco 16-port Flex Spectrum ROADM Line Card (16-WXC-FS) is a double-slot unit that provides multidegree switching capabilities not only at the individual wavelength level but also with flexible spectrum allocations. You can use the 16-port Flex Spectrum ROADM Line Card in the core of the network to build ROADM nodes with 96 channels spaced at 50-GHz, FlexSpectrum channels, or a combination of the two. By using a simple software reconfiguration, the same unit can provide colorless multiplexing and demultiplexing to ROADM nodes." Figure 4 of Cisco's NCS 2000 Data Sheet 2 provides a picture of the "16-port Flex Spectrum ROADM Line Card N-Degree ROADM Layout," which includes several WSS devices:  Cisco's ONS 15454 Data Sheet also states that it's 40-WXC-C component in its ROADM devices use "MEMS," which are micro-electromechanical mirrors, to switch (route/add/drop/attenuate/etc.) the signals.

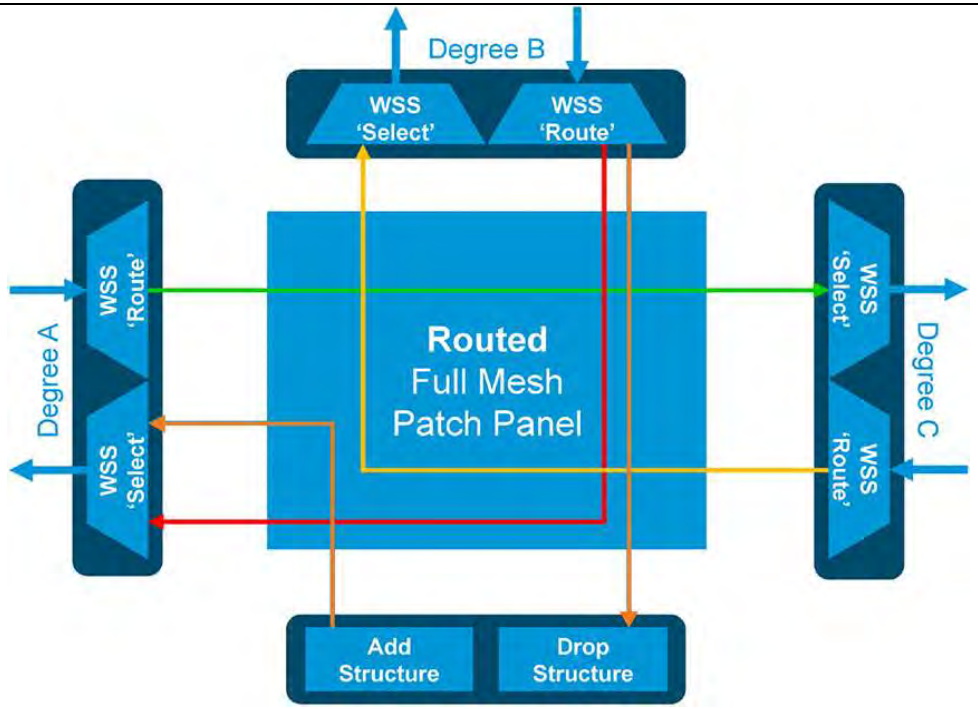
an input port for an input multi-wavelength optical signal having first spectral channels;	Cisco's ROADMs include an input port for an input multi-wavelength optical signal having first spectral channels. As shown in Cisco's ROADM Configuration Chapter about provisioning reconfigurable optical add/drop cards, Cisco's ROADM includes an input port for an input multi-wavelength optical signal having first spectral channels as follows: "The 40-WSS-C or 40-WSS-CE has eight types of ports: • ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C or 40-WSS-CE card also has one LC-PC-II optical connector for the main input. • COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter. • COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE. • EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C or 40-WSS-CE card in the same NE. • EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C or 40-WSS-CE card within the NE. • DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C(or 40-DMX-CE) card, where the channels are further processed and dropped. "The following figure shows a functional block diagram of the 40-WSS-C or 40-WSS-CE card: Figure 3: 40-WSS-C or 40-WSS-CE Block Diagram:" According to Cisco's NCS 2000 Data Sheet 2, Cisco's ROADM includes an input port for an input multi-wavelength optical signal having first spectral channels as follows: "The Cisco 16-port Flex Spectrum ROADM Line Card (16-WXC-FS) is a double-slot unit that provides multidegree switching capabilities not only at the individual wavelength level but also with flexible spectrum allocations. You can use the 16-port Flex Spectrum ROADM Line Card in the core of the

	network to build ROADM nodes with 96 channels spaced at 50-GHz, FlexSpectrum channels, or a combination of the two. By using a simple software reconfiguration, the same unit can provide colorless multiplexing and demultiplexing to ROADM nodes." Figure 4 of Cisco's NCS 2000 Data Sheet 2 provides a picture of the "16-port Flex Spectrum ROADM Line Card N-Degree ROADM Layout," which includes several WSS devices that include an input port for an input multi-wavelength optical signal having first spectral channels as follows: 
one or more other ports for second spectral channels;	Cisco's ROADMs include one or more other ports for second spectral channels. As shown in Cisco's ROADM Configuration Chapter about provisioning reconfigurable optical add/drop cards, Cisco's ROADM includes one or more other ports for second spectral channels as follows:

	"The 40-WSS-C or 40-WSS-CE has eight types of ports: • ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C or 40-WSS-CE card also has one LC-PC-II optical connector for the main input. • COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter. • COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE. • EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C or 40-WSS-CE card in the same NE. • EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C or 40-WSS-CE card within the NE. • DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C(or 40-DMX-CE) card, where the channels are further processed and dropped. "The following figure shows a functional block diagram of the 40-WSS-C or 40-WSS-CE card: Figure 3: 40-WSS-C or 40-WSS-CE Block Diagram:" According to Cisco's NCS 2000 Data Sheet 2, Cisco's ROADM includes one or more other ports for second spectral channels as follows: "The Cisco 16-port Flex Spectrum ROADM Line Card (16-WXC-FS) is a double-slot unit that provides multidegree switching capabilities not only at the individual wavelength level but also with flexible spectrum allocations. You can use the 16-port Flex Spectrum ROADM Line Card in the core of the network to build ROADM nodes with 96 channels spaced at 50-GHz, FlexSpectrum channels, or a combination of the two. By using a simple software reconfiguration, the same unit can provide colorless multiplexing and demultiplexing to ROADM nodes." Figure 4 of Cisco's NCS 2000 Data Sheet 2 provides a picture of the "16-port Flex Spectrum ROADM Line Card N-Degree ROADM Layout," which includes several WSS devices that include one or more other ports for second spectral channels as follows:

	
an output port for an output multi-wavelength optical signal;	Cisco's ROADMs include an output port for an output multi-wavelength optical signal. As shown in Cisco's ROADM Configuration Chapter about provisioning reconfigurable optical add/drop cards, Cisco's ROADM includes an output port for an output multi-wavelength optical signal: "The 40-WSS-C or 40-WSS-CE has eight types of ports: • ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C or 40-WSS-CE card also has one LC-PC-II optical connector for the main input. • COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and

	sends it to the optical splitter. • COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE. • EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C or 40-WSS-CE card in the same NE. • EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C or 40-WSS-CE card within the NE. • DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C(or 40-DMX-CE) card, where the channels are further processed and dropped. "The following figure shows a functional block diagram of the 40-WSS-C or 40-WSS-CE card: Figure 3: 40-WSS-C or 40-WSS-CE Block Diagram:" According to Cisco's NCS 2000 Data Sheet 2, Cisco's ROADM includes an output port for an output multi-wavelength optical signal as follows: "The Cisco 16-port Flex Spectrum ROADM Line Card (16-WXC-FS) is a double-slot unit that provides multidegree switching capabilities not only at the individual wavelength level but also with flexible spectrum allocations. You can use the 16-port Flex Spectrum ROADM Line Card in the core of the network to build ROADM nodes with 96 channels spaced at 50-GHz, FlexSpectrum channels, or a combination of the two. By using a simple software reconfiguration, the same unit can provide colorless multiplexing and demultiplexing to ROADM nodes." Figure 4 of Cisco's NCS 2000 Data Sheet 2 provides a picture of the "16-port Flex Spectrum ROADM Line Card N-Degree ROADM Layout," which includes several WSS devices that include an output port for an output multi-wavelength optical signal as follows:

	
a wavelength-selective device for spatially separating said spectral channels;	The Cisco ROADMs include a wavelength-selective device for spatially separating said spectral channels. According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes a a wavelength-selective device for spatially separating said spectral channels.
a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements	The Cisco ROADMs include a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.

being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.	According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide complete ROADM functionality and allow for the adding, dropping, multiplexing, switching, and routing of signals on an individual wavelength level. According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide ROADM functionality as follows: "The 40-WSS-C (or 40-WSS-CE) card works in combination with the 40-DMX-C (or 40-DMX-CE) card to implement ROADM functionality. As a ROADM node, the node can be configured at the optical channel level using CTC, Cisco Transport Planner, and CTM. ROADM functionality using the 40-WSS-C (or 40-WSS-CE) card requires two 40-WSS-C (or 40-WSS-CE) double-slot cards and two 40-DMX-C (or 40-DMX-CE) single-slot cards (for a total of six slots in the chassis)." According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide power monitoring functionality as follows: "The 40-WSS-C (or 40-WSS-CE) has physical diodes that monitor power at various locations on the card. The following table lists the physical diode descriptions." Cisco's ONS 15454 Data Sheet also states that it's 40-WXC-C component in its ROADM devices use "MEMS," which are micro-electromechanical mirrors, to switch (route/add/drop/attenuate/etc.) the signals.
7. The optical add-drop apparatus of claim 1 further comprising alignment mirrors for	The Cisco ROADMs described in claim 1 further include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.

adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.	As set forth in Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide "per-channel optical power monitoring using photodiodes" and "aggregate DWDM signal monitoring and control through a variable optical attenuator."

Cisco's ROADMs use at least a MEMs WSS. The WSS include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.	
8. The optical add-drop apparatus of claim 7 further comprising collimators associated with said alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.	The ROADMs described in claim 7 further comprise collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators. Cisco's ROADMs use at least a MEMs WSS. The WSS include collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.
13. The optical add-drop apparatus of claim 1, wherein said beam-deflecting elements comprise micromachined mirrors.	The beam deflecting elements of the ROADMs described in claim 1 comprise micromachined mirrors. Cisco's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include micromachined mirrors.

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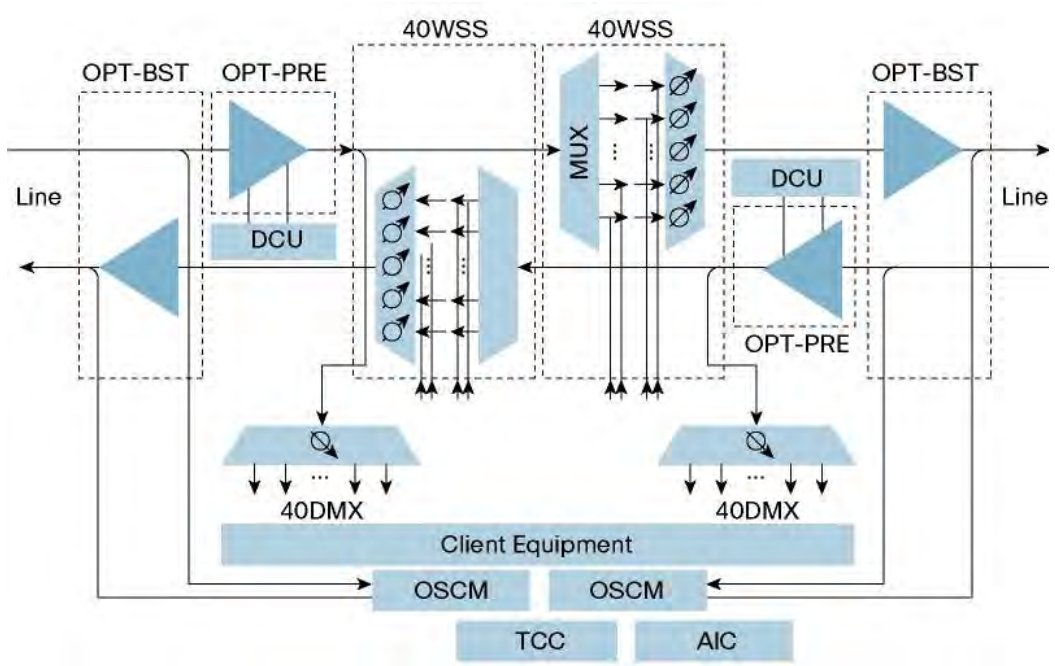
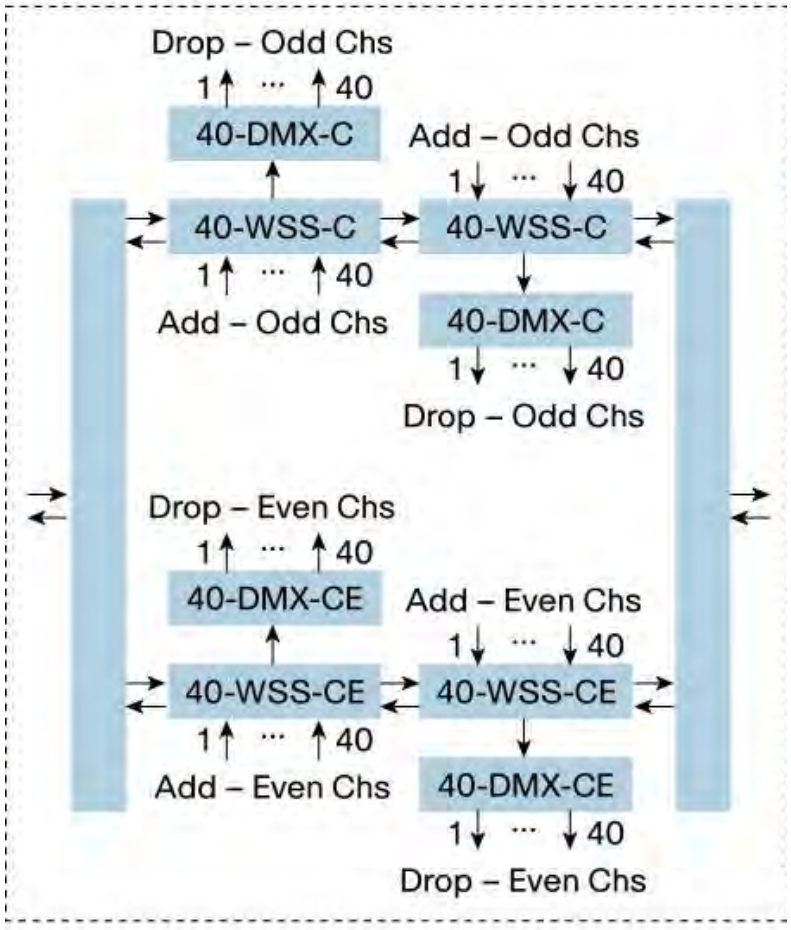
Claim 12 of U.S. Patent No. RE42,678
v.
Cisco Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Devices

Claim	Product Analysis
1. A wavelength-separating-routing apparatus, comprising:	Cisco makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Cisco's ROADM products, including: • "Data Sheet: 40-Channel Reconfigurable Optical Add/Drop Multiplexing Portfolio for the Cisco ONS 15454 Multiservice Transport Platform," dated 1992-2007 ("ONS 15454 Data Sheet"); • "Data Sheet: Cisco NCS 2000 Service Line Cards," dated 2013 ("NCS 2000 Data Sheet 1"); • "Data Sheet: Cisco Network Convergence System 2000 ROADM and Amplifier Line Cards," dated 2013 ("NCS 2000 Data Sheet 2"); • "Cisco ONS 15200 Series DWDM Systems," from Cisco's website (www.cisco.com/c/en/us/products/optical-networking/ons-15200-series-dwdm-systems/index.html) ("ONS 15200 Webpage"); • "Data Sheet: Cisco ONS 15216 C L-Band Splitter/Combiner Module for Cisco ONS 15454 MSTP" dated 1992-2005 ("ONS 15200 Data Sheet"); • "Cisco NCS 2002 and NCS 2006 Line Card Configuration Guide, Release 10.x.x," chapter titled "Provisioning Reconfigurable Optical Add/Drop Cards," which "describes the line cards deployed in reconfigurable optical add/drop (ROADM) networks," pp12-16, which focus on the "40-WSS-C and 40-WSS-CE Card," and pp 31-38, which focus on "Single Module ROADM (SMR-C) Cards" ("ROADM Configuration Chapter"); and • information and documents available from Cisco's website (www.cisco.com) ("Website"). According to Cisco's ONS 15454 Data Sheet: "The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) (Figure 1) provides a comprehensive, intelligent dense wavelength-division multiplexing (DWDM) solution for expanding metropolitan (metro) and regional bandwidth."

	Figure 1 is labeled as "40-Channel Wavelength Cross-Connect (40-WXC), Wavelength Selective Switch (40-WSS), Multiplexer (40-MUX), and Demultiplexer (40-DMX) Units." "While Wavelength Selective Switch (WSS) units provide degree-2 type reconfigurability (drop wavelength in a node vs. let it pass through the node), an ROADM node based on 40-WXC units can support up to degree-8 reconfigurability. This means that for each wavelength it is possible to decide if it has to be locally dropped or routed to any of the other 7 pass-through directions of the node. Such a capability not only enhances the flexibility of the DWDM transport network but also dramatically reduces the need for costly transponders to perform optical-to-electrical-to-optical conversion (typically 2 transponders/crossponders per add/drop channel or wavelength)." "As even in complex mesh network topologies it is likely that degree-2 reconfigurability would be enough for most of the node, the 40-channel ROADM portfolio includes also two different versions of the 40-WSS units, one operating on the odd channels of the C band spectrum (40-WSS-C) and the other one operating on the even channels of the C band spectrum (40-WSS-CE). The units can be used in conjunction with existing 32-channel ROADM solutions and with 40-WXC units to provide the greatest degree of flexibility for Cisco ONS 15454 MSTP deployments." "Embedded automatic power control mechanisms feature the possibility to interface with different types of DWDM units without requiring external attenuators. Used in conjunction with the 40-channel Multiplexer and 40-channel Demultiplexer allows to manage local add/drop traffic of the specific direction supported by the 40-WXC unit." "Embedded automatic power control mechanisms feature the possibility to interface with different type of DWDM units without requiring external attenuators." A chart in Cisco's ONS 15454 Data Sheet lists the components within the 40-Channel ROADM Units, including a "40-Channel Wavelength Selective Switch" The following figure 3 from Cisco's ONS 15454 Data Sheet is a chart of the "MSTP 40-Channel Degree-2 ROADM Node" and shows how wavelength selective switches (labeled "WSS") are integrated within a Cisco's ROADM:



The following figure 4 from Cisco's ONS 15454 Data Sheet is a chart of the "MSTP 80-Channel Degree-2 ROADM Node" and shows how wavelength selective switches (labeled "WSS") are integrated within a Cisco's ROADM and how Cisco's ROADM can add and drop signals:

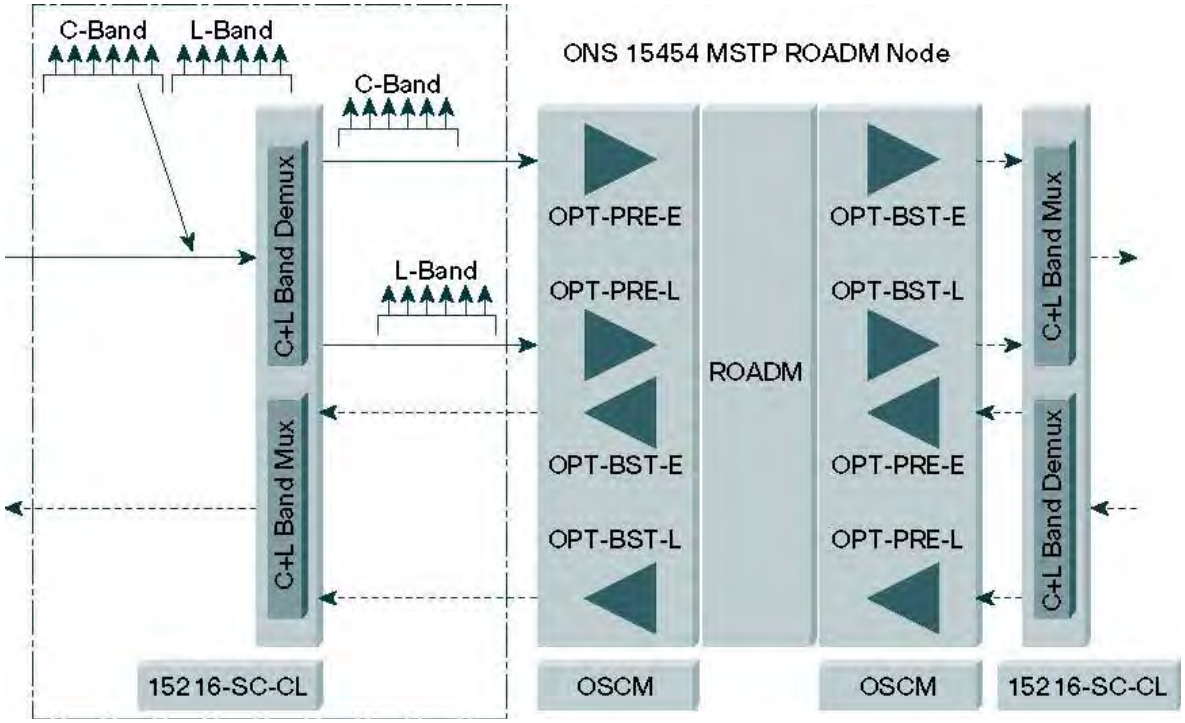


According to Cisco's ONS 15200 Data Sheet and ONS 15200 Webpage, both of which describe the ONS 15200 series of Cisco products, the ONS 15216 is the front end to the WSS ROADM in the ONS 15454. The ONS 15216 and ONS 15454 are integral to one another, so the ONS 15216 cannot work without the ONS 15454 and vice versa.

According to Cisco's ONS 15200 Webpage, "Cisco ONS 15200 Series DWDM Systems consist of intuitive,

compact, passive devices used in a variety of applications. These range from low latency, point-to-point data center interconnect to passive or reconfigurable optical add/drop multiplexer- (ROADM) based metropolitan rings."

According to Cisco's ONS 15200 Data Sheet, Figure 3 describes "Cisco ONS 15216 C+L-Band Splitter/Combiner Module Deployed in a Cisco ONS 15454 MSTP ROADM Node" and depicts the relationship of Cisco's 15200 series products with Cisco's 15454 ROADM as follows:

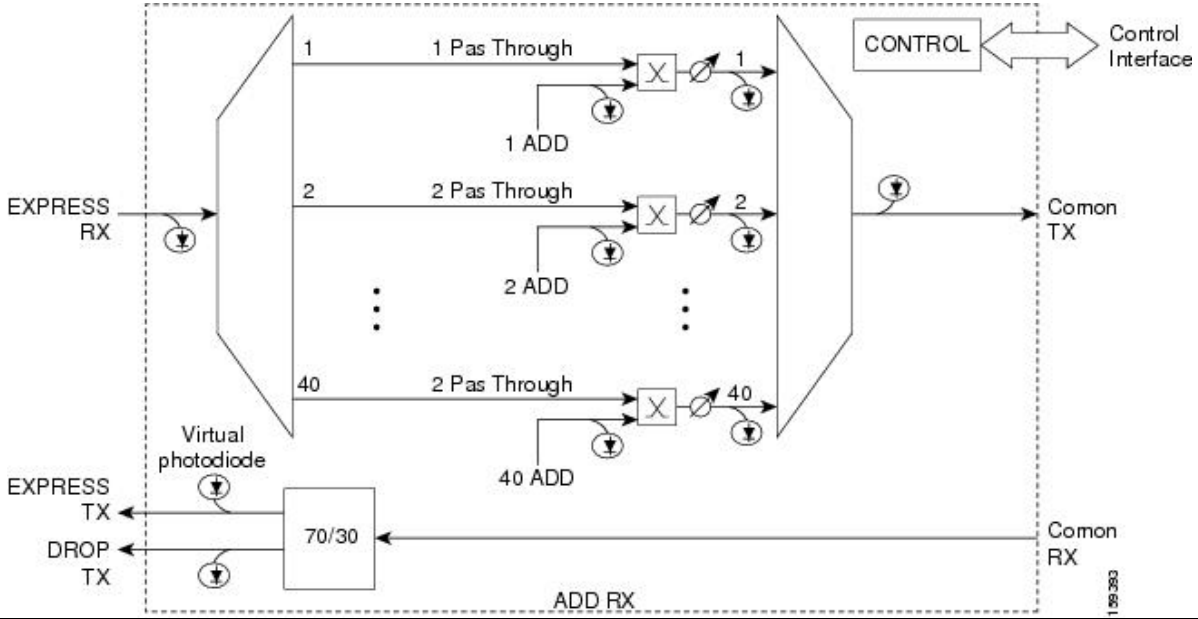


According to Cisco's ROADM Configuration Chapter, the Single Module ROADM (SMR-C) Cards are "single-slot 40-channel single module ROADM (SMR-C) cards" and they "integrate the following functional blocks onto a single line card:

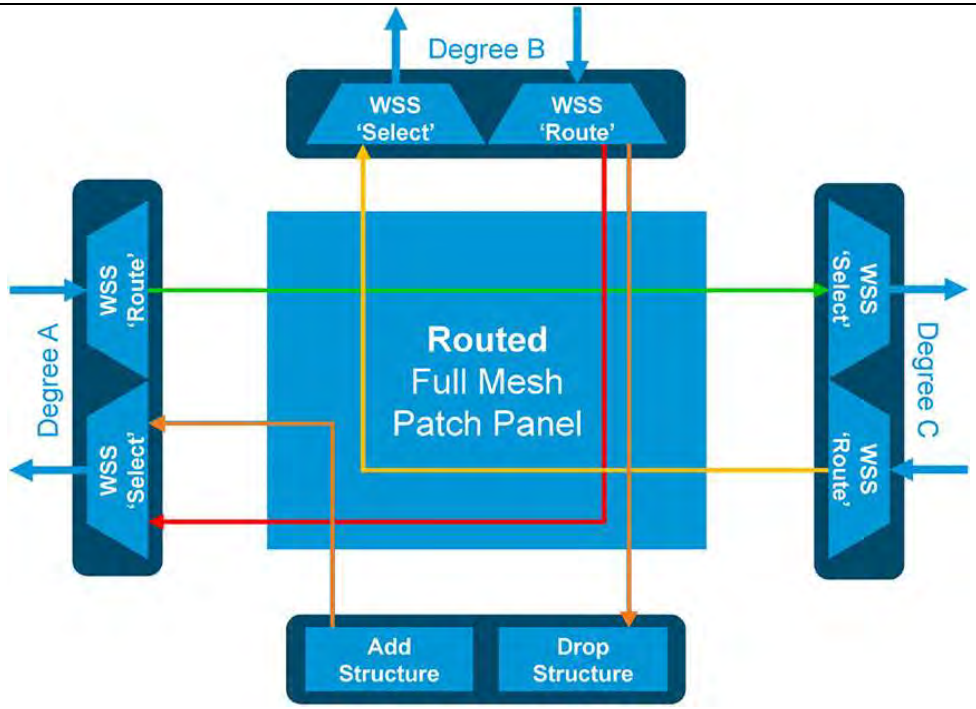
"• Optical preamplifier

• Optical booster amplifier

	• Optical service channel (OSC) filter • 2x1 wavelength cross-connect (WXC) or a 4x1 WXC • Optical channel monitor (OCM)" According to Cisco's ROADM Configuration Chapter, the Single Module ROADM (SMR-C) Cards "can manage up to 40 channels spaced at 100GHz on each port." Cisco's ROADM Configuration Chapter about provisioning reconfigurable optical add/drop cards describes the "40-WSS-C and 40-WSS-CE Card" as follows: "The double-slot 40-channel wavelength selective switch C-band (40-WSS-C) or the double-slot 40-channel wavelength selective switch even-channel C-band (40-WSS-CE) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 4: Channel Allocation Plan or Table 5: Channel Allocation Plan) and sends them to dedicated output ports. The 40-WSS-C or 40-WSS-CE card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17 "The 40-WSS-C or 40-WSS-CE features include: • Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction. • Per-channel optical power monitoring using photodiodes. • Signal splitting in a 70%-to-30% ratio, sent to the 40-DMX-C (or 40-DMX-CE) for dropping signals, then to the other 40-WSS-C (or 40-WSS-CE) card. • Aggregate DWDM signal monitoring and control through a variable optical attenuator (VOA). In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available." "Within the 40-WSS-C or 40-WSS-CE card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port." "The 40-WSS-C or 40-WSS-CE has eight types of ports: • ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an

	individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C or 40-WSS-CE card also has one LC-PC-II optical connector for the main input. • COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter. • COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE. • EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C or 40-WSS-CE card in the same NE. • EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C or 40-WSS-CE card within the NE. • DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C(or 40-DMX-CE) card, where the channels are further processed and dropped. “The following figure shows a functional block diagram of the 40-WSS-C or 40-WSS-CE card: Figure 3: 40-WSS-C or 40-WSS-CE Block Diagram:” 

	According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide ROADM functionality as follows: "The 40-WSS-C (or 40-WSS-CE) card works in combination with the 40-DMX-C (or 40-DMX-CE) card to implement ROADM functionality. As a ROADM node, the node can be configured at the optical channel level using CTC, Cisco Transport Planner, and CTM. ROADM functionality using the 40-WSS-C (or 40-WSS-CE) card requires two 40-WSS-C (or 40-WSS-CE) double-slot cards and two 40-DMX-C (or 40-DMX-CE) single-slot cards (for a total of six slots in the chassis)." According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide power monitoring functionality as follows: "The 40-WSS-C (or 40-WSS-CE) has physical diodes that monitor power at various locations on the card. The following table lists the physical diode descriptions." According to Cisco's NCS 2000 Data Sheet 2, Cisco provides a ROADM as follows: "The Cisco 16-port Flex Spectrum ROADM Line Card (16-WXC-FS) is a double-slot unit that provides multidegree switching capabilities not only at the individual wavelength level but also with flexible spectrum allocations. You can use the 16-port Flex Spectrum ROADM Line Card in the core of the network to build ROADM nodes with 96 channels spaced at 50-GHz, FlexSpectrum channels, or a combination of the two. By using a simple software reconfiguration, the same unit can provide colorless multiplexing and demultiplexing to ROADM nodes." Figure 4 of Cisco's NCS 2000 Data Sheet 2 provides a picture of the "16-port Flex Spectrum ROADM Line Card N-Degree ROADM Layout," which includes several WSS devices:

	 Cisco's ONS 15454 Data Sheet also states that it's 40-WXC-C component in its ROADM devices use "MEMS," which are micro-electromechanical mirrors, to switch (route/add/drop/attenuate/etc.) the signals.
a) multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports;	The Cisco ROADMs include multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports. According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes multiple fiber collimators, providing an input for multi-wavelength optical signal and a plurality of output ports.
b) a wavelength-separator, for separating said multi-wavelength optical signal from said input port	The Cisco ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels.

into multiple spectral channels;	According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels.
c) a beam-focuser, for focusing said spectral channels into corresponding spectral spots; and	The Cisco ROADMs include a beam-focuser, for focusing said spectral channels into corresponding spectral spots. According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes a beam-focuser, for focusing said spectral channels into corresponding spectral spots.
d) a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports.	The Cisco ROADMs include a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Cisco's Data Sheets and website, Cisco's ROADM products include a WSS-based card ("switching module"). The switching module includes a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide complete ROADM functionality and allow for the adding, dropping, multiplexing, switching, and routing of signals on an individual wavelength level. According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide ROADM functionality as follows: "The 40-WSS-C (or 40-WSS-CE) card works in combination with the 40-DMX-C (or 40-DMX-CE) card to implement ROADM functionality. As a ROADM node, the node can be configured at the optical channel level

	using CTC, Cisco Transport Planner, and CTM. ROADM functionality using the 40-WSS-C (or 40-WSS-CE) card requires two 40-WSS-C (or 40-WSS-CE) double-slot cards and two 40-DMX-C (or 40-DMX-CE) single-slot cards (for a total of six slots in the chassis)." According to Cisco's ROADM Configuration Chapter, Cisco's WSS cards provide power monitoring functionality as follows: "The 40-WSS-C (or 40-WSS-CE) has physical diodes that monitor power at various locations on the card. The following table lists the physical diode descriptions." Cisco's ONS 15454 Data Sheet also states that it's 40-WXC-C component in its ROADM devices use "MEMS," which are micro-electromechanical mirrors, to switch (route/add/drop/attenuate/etc.) the signals.
12. The wavelength-separating-routing apparatus of claim 1 wherein each channel micro-mirror is a silicon micromachined mirror.	The channel micromirrors of the ROADMs described in claim 1 are silicon micromachined mirrors. Cisco ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include silicon micromachined mirrors.

Claims 1-2 of U.S. Patent No. RE42,368
v.
Coriant Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. An optical add-drop apparatus comprising:	Coriant makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Coriant is a successor company to Nokia Siemens Optical GmbH ("Nokia Siemens") and to its ROADMs – the hiT7300 or SURPASS hiT 7300. *See* http://en.wikipedia.org/wiki/Coriant; http://www.lightreading.com/coriant-separates-from-nsn/d/d-id/702535; http://www.lightwaveonline.com/articles/2013/03/ex-nsn-optical-division-anticipates-new-start-as-coriant.html. Several documents detail the functionality of Coriant's ROADM products, including: • "Hardware and Functionality" documenting the features of the SURPASS 7300 ROADM, from Nokia Siemens, dated 2011 ("Specifications"); • "Datasheet: SURPASS hiT 7300, Next-Generation Nulti-Haul DWDM Platform," from Nokia Siemens, dated 2007 ("Datasheet"); and • information and documents available from Coriant's website (http://www.coriant.com/products/hit7300.asp) ("Website") (collectively, ROADM Materials"). According to Tellabs's Specifications, the hiT 7300 uses wavelength selective switches ("WSS") as follows:

2.2.3 Wavelength-Selective Switch Cards

The filter cards act as multiplexers/demultiplexers by providing the primary wave division or aggregation of all the transponder signals and allowing access (add/drop) to a particular set of wavelengths from an optical fiber while passing the remaining wavelengths. Line side wavelengths require translation to client side equipment via the transponder card.

The following Wavelength-Selective Switch cards are supported in hiT 7300:

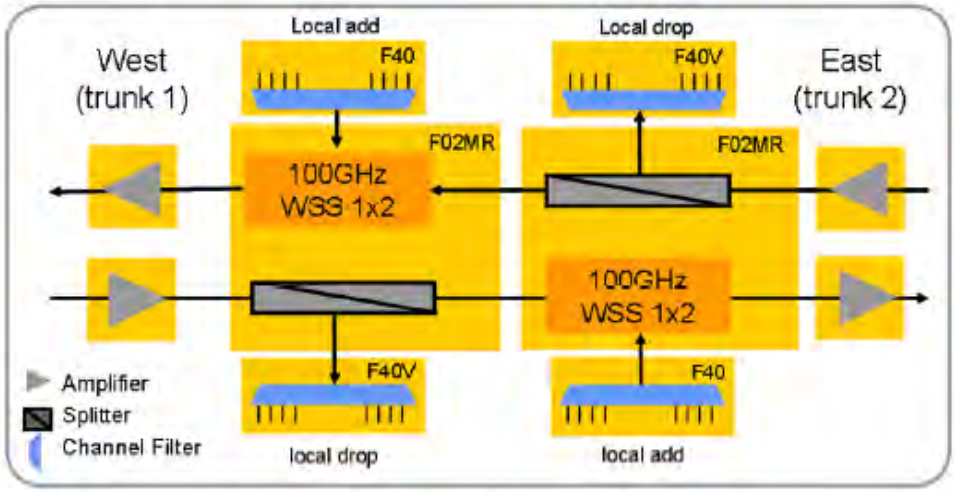
Wavelength-Selective Switch Cards			
Card name	**Usage** Optical multiplexer of	**Architecture**	**Communication type**
F40MR-1	a ROADM	PLC-WSS	Bidirectional
F02MR-1	an ONN-R2	MEMS-WSS	Bidirectional
F08MR-1	reconfigurable PXC	MEMS-WSS	Bidirectional
F06DR80-1	Optical demultiplexer of a reconfigurable PXC	MEMS-WSS	Unidirectional
F06MR80-1	a reconfigurable PXC	MEMS-WSS	Unidirectional
F09DR80-1	Optical demultiplexer of a reconfigurable PXC	PLC-WSS	Unidirectional
F09MR80-1	a reconfigurable PXC	PLC-WSS	Unidirectional
F09MDRT-1/S	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDRT-1/O	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDR96-1	an ONN-X96	Tunable WSS	Bidirectional
O09CC-1	an ONN-X96	Coupler card for color- and directionless PXC	Bidirectional
F80DCI-1	Optical demultiplexer of a ROADM	Interleaver filter and splitter	Unidirectional
F80MDI-1	Optical multiplexer or demultiplexer	Interleaver filters	Bidirectional

	According to Tellabs's Specifications, the hiT 7300 operates with various WSS cards as follows: 2.2.3.1 F40MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a ROADM providing full access to 40 optical channels. The key component for this application is the F40MR-1 card which includes an integrated Planar Lightwave Circuit-Wavelength Selective Switch (PLC-WSS) with low insertion loss, providing a remotely (via software) reconfigurable optical switching function per individual wavelength. 2.2.3.2 F02MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a cost optimized nodal degree 2 ROADM (i.e., ONN-R2) providing full access to 40 optical channels. The key component for this application is the F02MR-1 card which includes in the transmission path an integrated 2:1 Micro-Electro-Mechanical System - Wavelength Selective Switch (MEMS-WSS) module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

	2.2.3.3 F08MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a multi-degree 40-channel PXC providing full access to 40 optical channels. The key component for this application is the F08MR-1 card which includes an integrated 8:1 MEMS-WSS module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength. The input DWDM signal from the line interface (optical pre-amplifier) is split into 7 crossconnect outputs and 1 local drop traffic output. The drop output also provides an optical input power monitor for detection of Loss Of Signal (LOS) and laser safety control. The **WSS module** collects DWDM traffic from 7 other line ports and 1 local add traffic input, and performs arbitrary pass-through switching for any wavelength, of the 8 input ports, toward its output port. The internal cross-connect traffic ports from different F08MR-1 cards (of different line directions) can be interconnected to allow a configurable pass-through traffic between arbitrary line directions.

	2.2.4.2 ONN-R2 with F02MR-1 - Wavelength-Selective Switch (WSS) Card The F02MR is a cost optimized alternative to the F40MR card. It includes an integrated MEMS WSS based wavelength selective switch (MEMS-WSS) with low insertion loss, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. In the Tx path, the key component of this card is the integrated MEMS based 2:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via NMS) reconfigurable optical switching function per individual wavelength. The incoming signals of the cross-connect are switched with the WSS module on the common output which is followed by a booster amplifier. One of the inputs of the WSS is connected to the output of a mux filter where the local add channels are inserted. In the RX path, the incoming signal from the pre-amplifier is launched into a 1x2 splitter with a 40/60 splitting ratio. At the higher output port, a demux filter (F40/S) can be connected for local drop traffic. The other port is the output of the cross-connect. At both inputs of the WSS and the C-COM port of the splitter, LOS monitors are used for supervision. Also a power monitor is present at the splitter drop output.

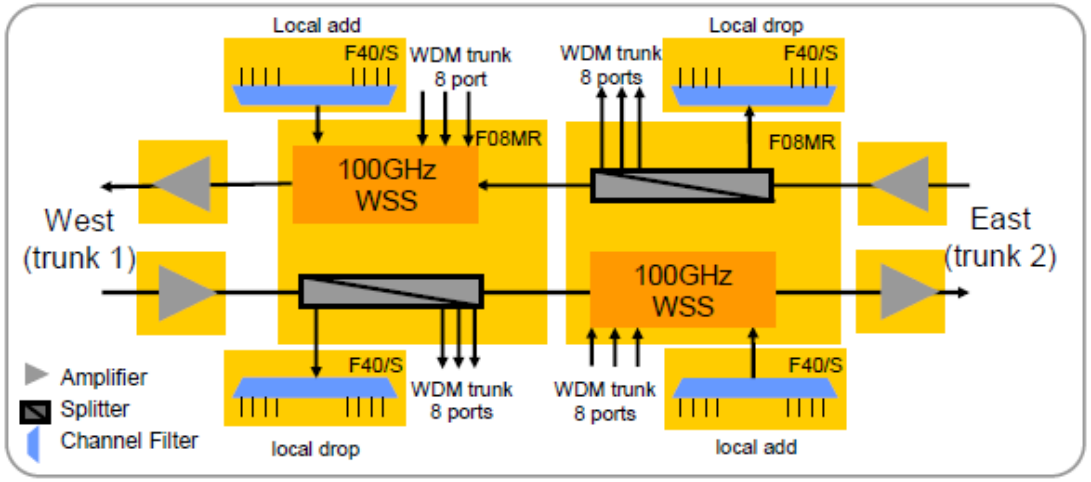
ROADM architecture for 40 channels, ONN-R2



- Nodal degree 1..2, in-service upgrade from terminal to ROADM
- Alternatively: F40MR based on PLC technology can be used with integrated VOAs, channel power monitors, and local add filters
- East-west separation per design
- support of patch through on drop side to ROADM node in 2nd ring (ring interconnect)

	2.2.4.3 ONN-X with F08MR card 40-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS) The F08MR card which includes an integrated MEMS based 8:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is optically splitted into 7 cross-connect outputs and 1 local drop traffic output, where the drop output also provides an optical input power monitor for detection of loss-of-signal and laser safety control. The WSS module collects DWDM traffic from 7 other line ports and 1 local add traffic input and performs arbitrary pass-through switching for any wavelengths from any input of its 8 input ports towards its output port. The internal cross-connect traffic ports from different F08MR cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS unit supports hitless wavelength switching for any unchanged optical channel interconnections.

Photonic Cross Connect (PXC) for 40 channels

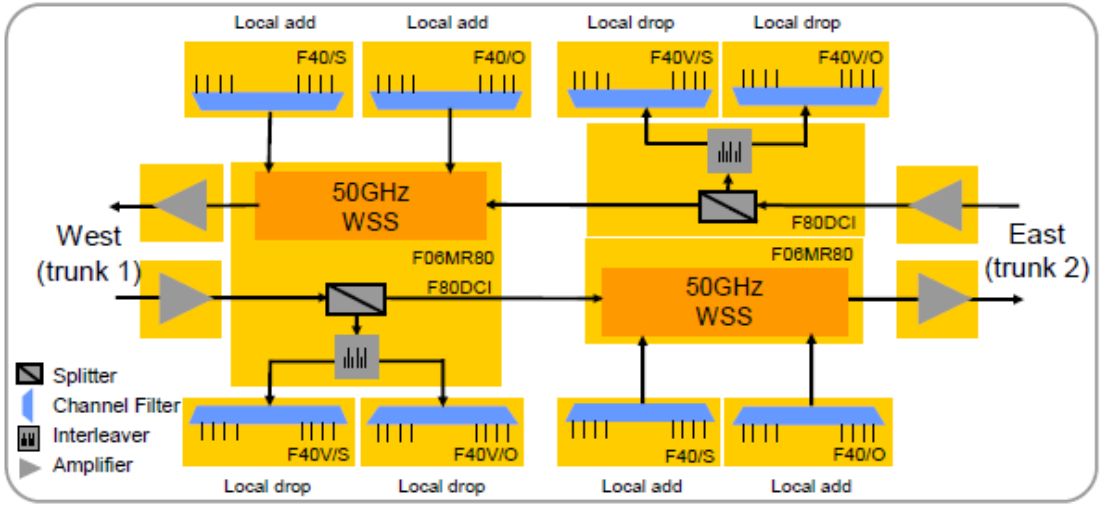


- PXC, supporting nodal degree 8
- one WSS for channels add and one splitter for channel drop per nodal degree
- fully remotely configurable
- east-west separation
- (only two degree shown in figure)

For internal use

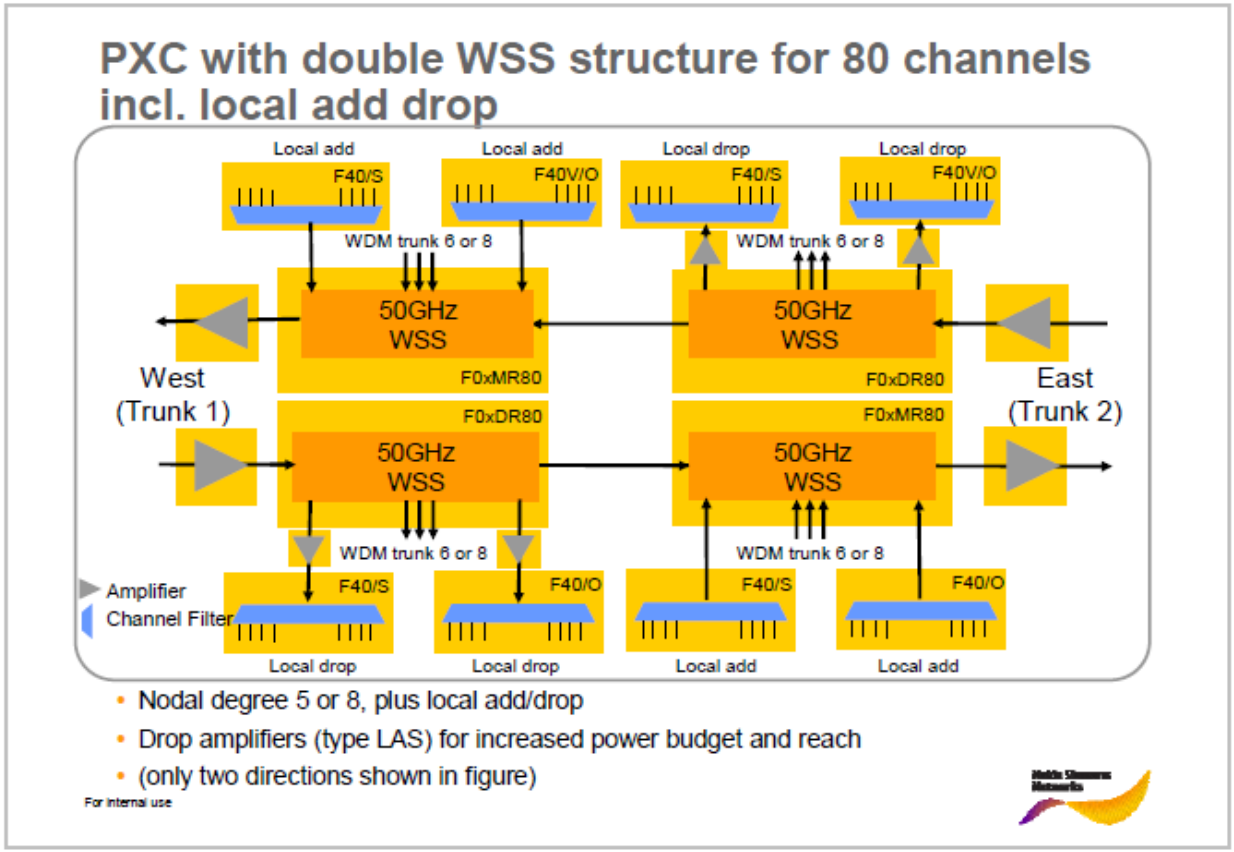
	2.2.4.5 ONN-X with F0xDR80 and the F0xMR80 cards (80-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS)) The F0xDR80 and the F0xMR80 cards each including an integrated MEMS based 1:6 (6:1) or 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F0xDR80 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 40-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M. The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F0xMR80 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 40-channel frequency groups of standard grid and offset grid. The internal cross-connect traffic ports from F0xDR80 and F0xMR80 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.

Remotely configurable ROADM – 80 channels

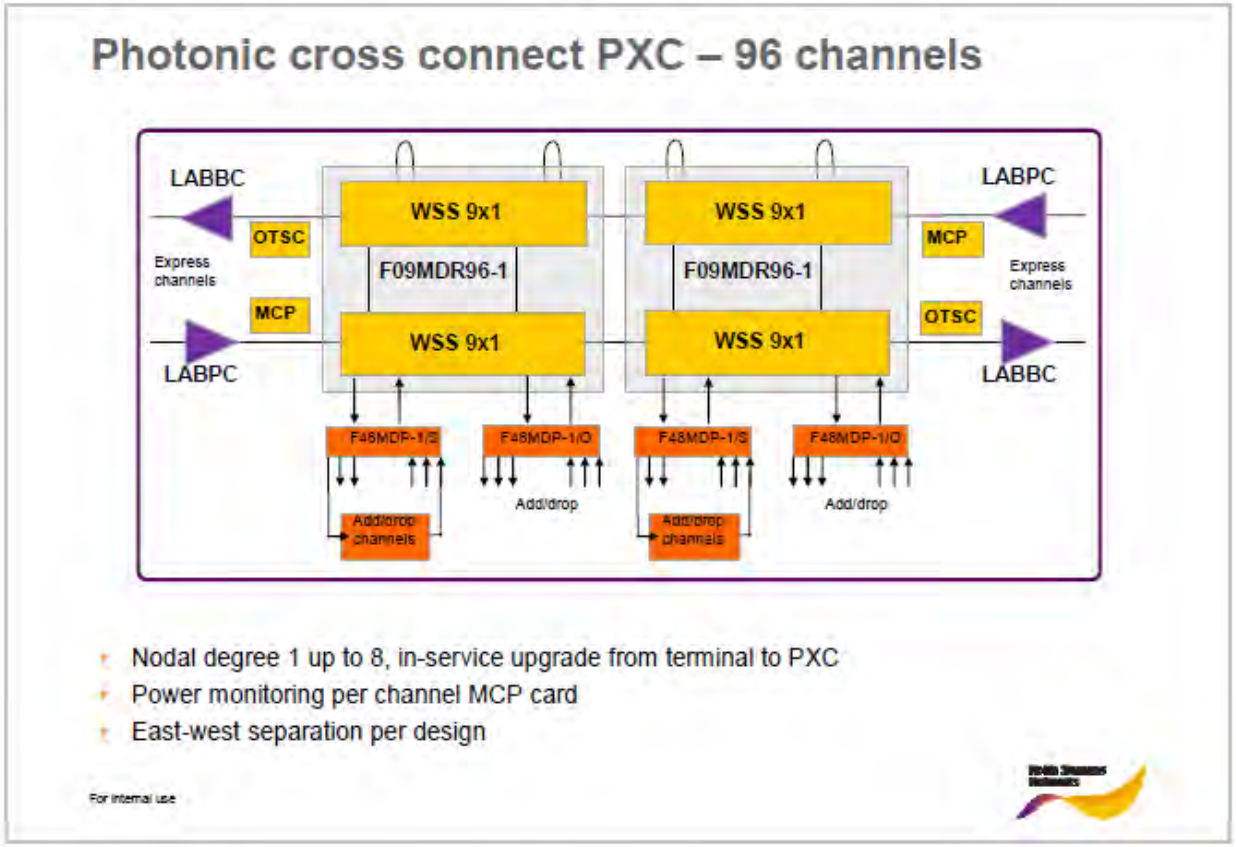


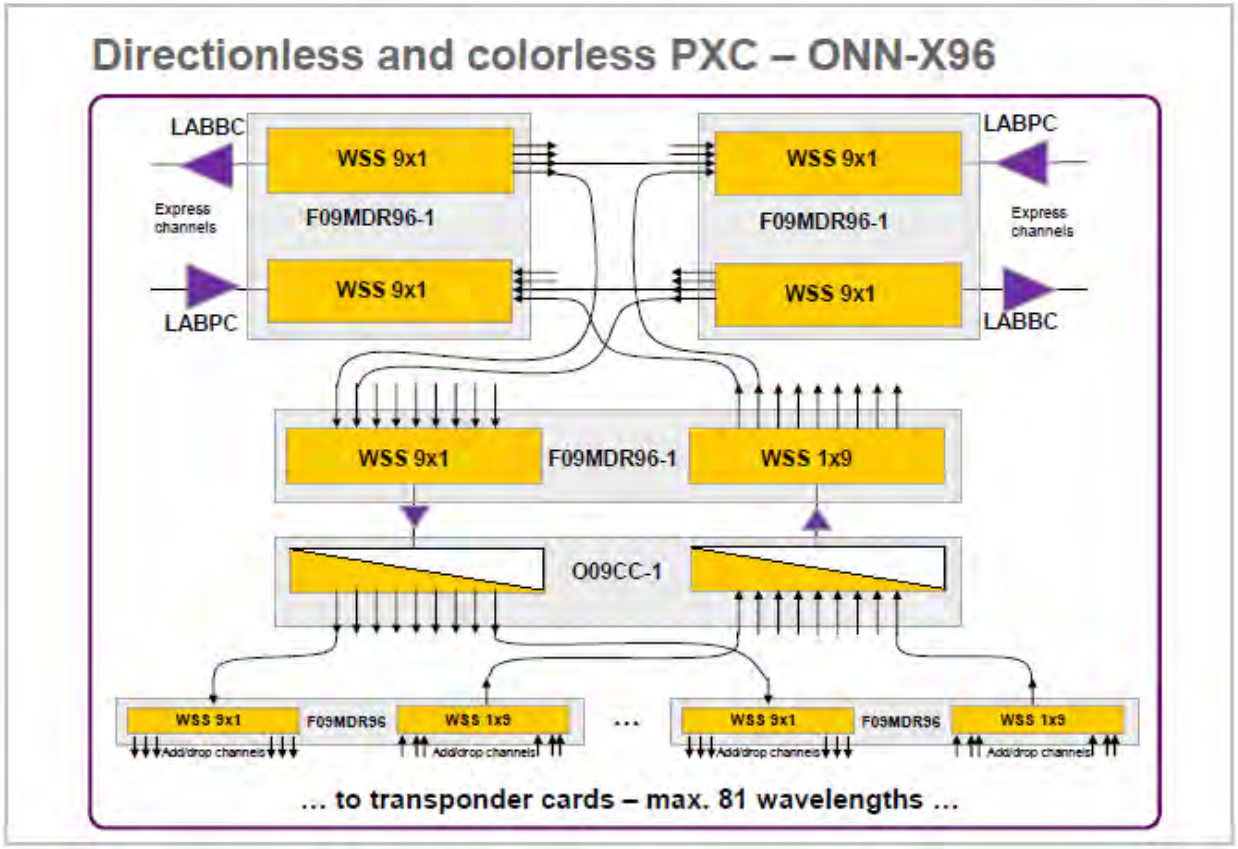
- Nodal degree 2, in-service upgrade from terminal to ROADM
- Power monitoring per channel via one MCP card
- East-west separation per design

For internal use


PXC with double WSS structure for 80 channels incl. local add drop
Local add
Local add
Local drop
Local drop
F40/S
F40V/O
F40/S
F40V/O
WDM trunk 6 or 8
WDM trunk 6 or 8
50GHz WSS
50GHz WSS
F0xMR80
F0xDR80
West (Trunk 1)
East (Trunk 2)
F0xDR80
F0xMR80
50GHz WSS
50GHz WSS
WDM trunk 6 or 8
WDM trunk 6 or 8
Amplifier
Channel Filter
F40/S
F40/O
F40/S
F40/O
Local drop
Local drop
Local add
Local add
• Nodal degree 5 or 8, plus local add/drop
• Drop amplifiers (type LAS) for increased power budget and reach
• (only two directions shown in figure)
For internal use

	2.2.4.6 ONN-X96 with F09MDR96-1 cards (MEMS-WSS)) The F09MDR96-1 card include an integrated MEMS based 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F09MDR96-1 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 48-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M. The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F09MDR96-1 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 48-channel frequency groups of standard grid and offset grid. The internal cross-connect traffic ports from F09MDR96-1 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.


Photonic cross connect PXC – 96 channels
LABBC
LABPC
WSS 9x1
WSS 9x1
OTSC
MCP
Express channels
F09MDR96-1
F09MDR96-1
MCP
OTSC
Express channels
WSS 9x1
WSS 9x1
LABPC
LABBC
F48MDP-1/S
F48MDP-1/O
F48MDP-1/S
F48MDP-1/O
Add/drop
Add/drop
Add/drop channels
Add/drop channels
Nodal degree 1 up to 8, in-service upgrade from terminal to PXC
Power monitoring per channel MCP card
East-west separation per design
For internal use



According to Tellabs's Specifications, the hiT 7300 has channel power monitors as follows:

2.7.13 Channel power monitor (MCP4x-x) card

The channel power monitor card MCP4x-x provides an in-service monitoring of the optical channel power levels. The card contains an Optical Spectrum Analyzer (OSA) for 40/80 channels, which is periodically connected to 4 optical input ports.

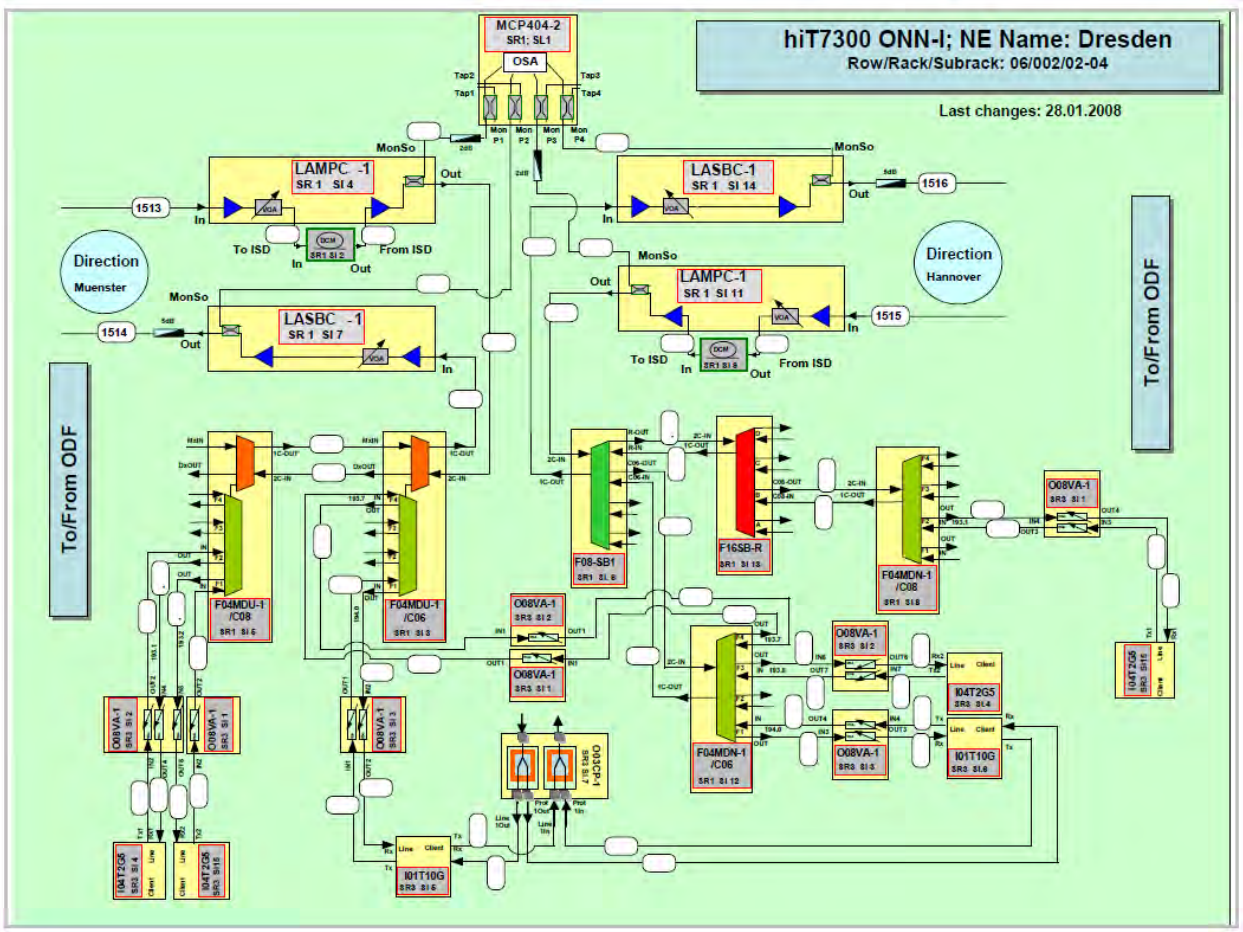
There is three different types of the channel power monitor card are available:

Card name	Supported bit rates	Usage
MCP404-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP404-2	2.5 Gbit/s; 10 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP4-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	80 channels (within 50 GHz grid) monitoring

The MCP4x-x card is used for:

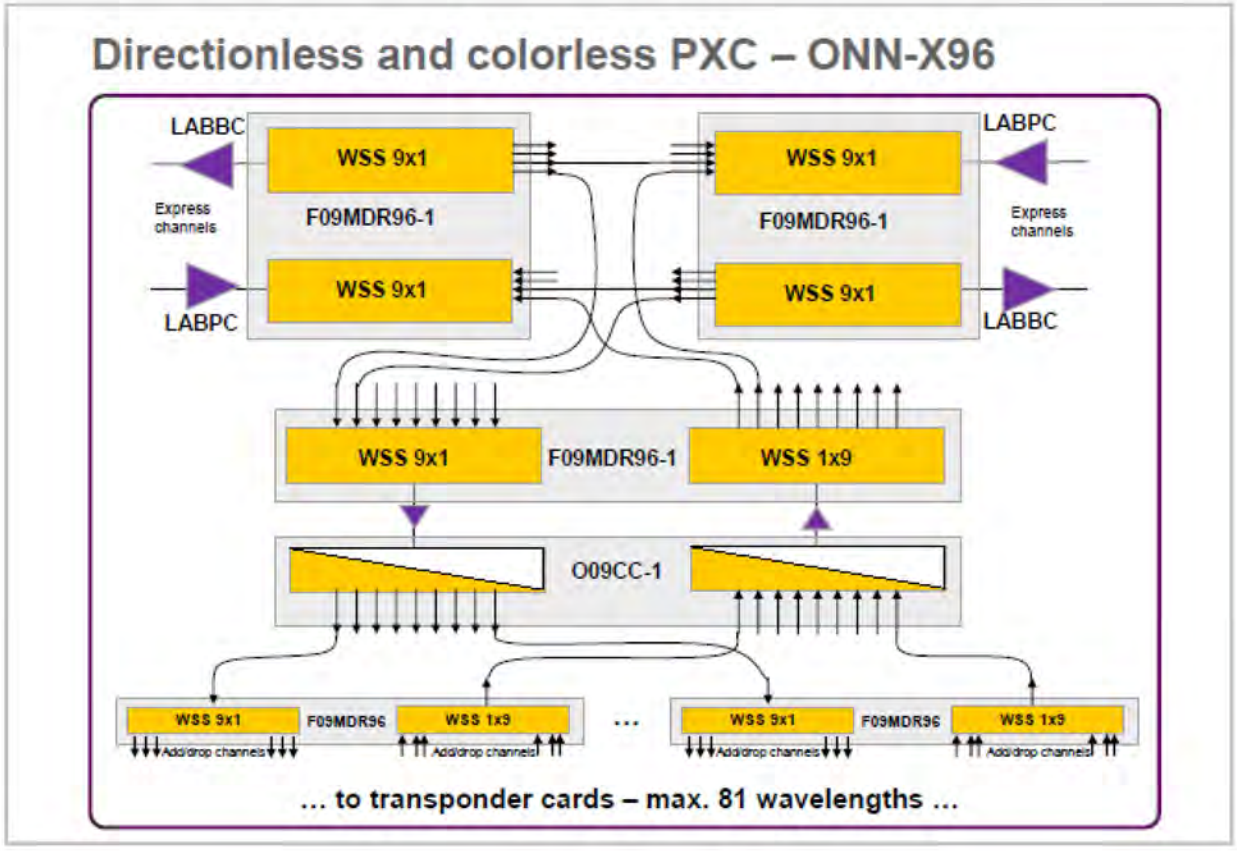
- In-service measurement of optical channel power levels of the 40 channels on a 100 GHz grid at the source monitoring output port which is used for all optical amplifier card types as well as for the OSC termination card (LIFB-1).
- Measurement of an automated enhanced pre-emphasis configuration on an optical pre-emphasis section (i.e., a link with full channel multiplexing/demultiplexing). Using MCP4xx-x card at the beginning and end of a link in combination with an attenuator card, provides a fully automated optical link commissioning and an in service channel upgrade.
- Measurement of an automatic in-service amplifier tilt control. Using MCP4xx-x card at the beginning and end of a link, allows tilt correction values to be distributed over the whole link.
- Automatic performance measurement and supervision of optical carriers with autonomous start of measurement cycle every 300 seconds.

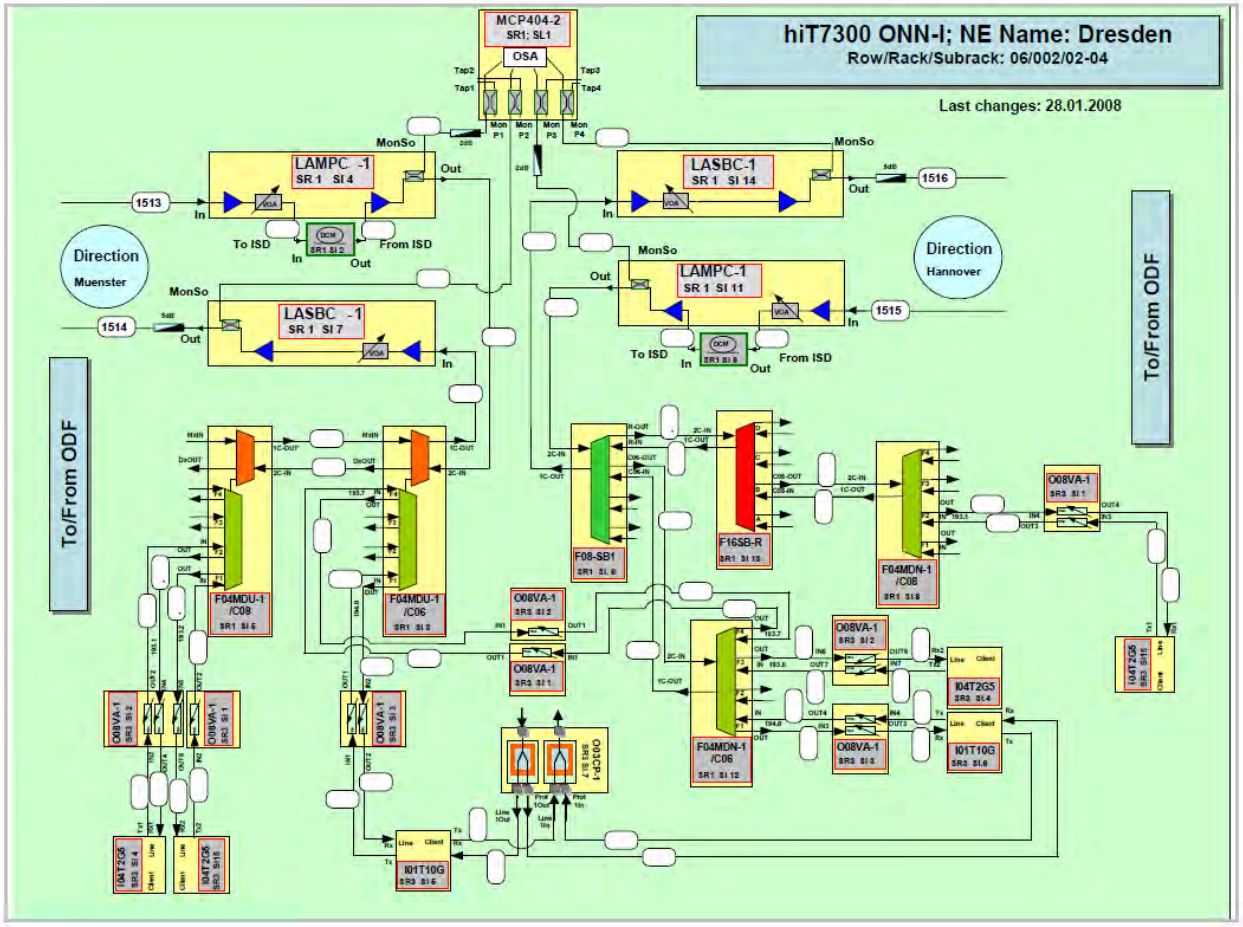
According to Tellabs's Specifications, the hiT 7300 is arranged in configurations that include multiple input ports, output ports, and pass through ports, and the spectral channels are directed among these ports at the individual wavelength level in any manner of arrangements as follows:



According to Tellabs's Datasheet, the hiT 7300 has the following key features:

	SURPASS hiT 7300 key features • Comprehensive automation of commissioning, service provisioning and software upgrading • Customized network configuration and operation (customizable parameters and GUI) • Up to 40 channels, with optional extension to 80 channels, with a maximum 1,600 km reach at up to 40 Gbit/s per channel • Full range of client interfaces enabling Ethernet (GE, 10GE), SAN, TDM and OTH services • SNMP and TL-1 management interfaces • Ultra-flexible solutions for OADM, ROADM and PXC • OMS and channel protection • Enabled for ultra-long spans and hut skipping • Purely passive CWDM or DWDM applications • Remote network termination • Tunable laser transponder (full C-band) for fast provisioning of transparent end-to-end services and reduced spares cost • Remote access and highly effective automation: No system-specific know-how or laptop required for any on-site installation, commissioning, provisioning • "Flight recorder": Download all diagnostic data from NE with single mouse click for fast troubleshooting • Interactive online help for all network elements • Full G.709 implementation enables OTH functionality including end-to-end provisioning and management of wavelengths across multiple vendor sub-net-works • Standard ETSI/ANSI rack mounting (collocation applications are enabled) • NEBS3 compliant
an input port for an input multi-wavelength optical signal having first spectral channels;	Tellabs's ROADMs include an input port for an input multi-wavelength optical signal having first spectral channels. According to Tellabs's ROADM Materials, Tellabs' ROADM necessarily includes an input port for an input multi-wavelength optical signal having first spectral channels because the hiT 7300 is arranged in configurations that include multiple input ports, output ports, and pass through ports, and the spectral channels are directed among these ports at the individual wavelength level in any manner of arrangements as follows:


Directionless and colorless PXC – ONN-X96
LABBC
WSS 9x1
Express channels
F09MDR96-1
WSS 9x1
LABPC
WSS 9x1
LABPC
WSS 9x1
Express channels
F09MDR96-1
WSS 9x1
LABBC
WSS 9x1
F09MDR96-1
WSS 1x9
O09CC-1
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
...
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
... to transponder cards – max. 81 wavelengths ...



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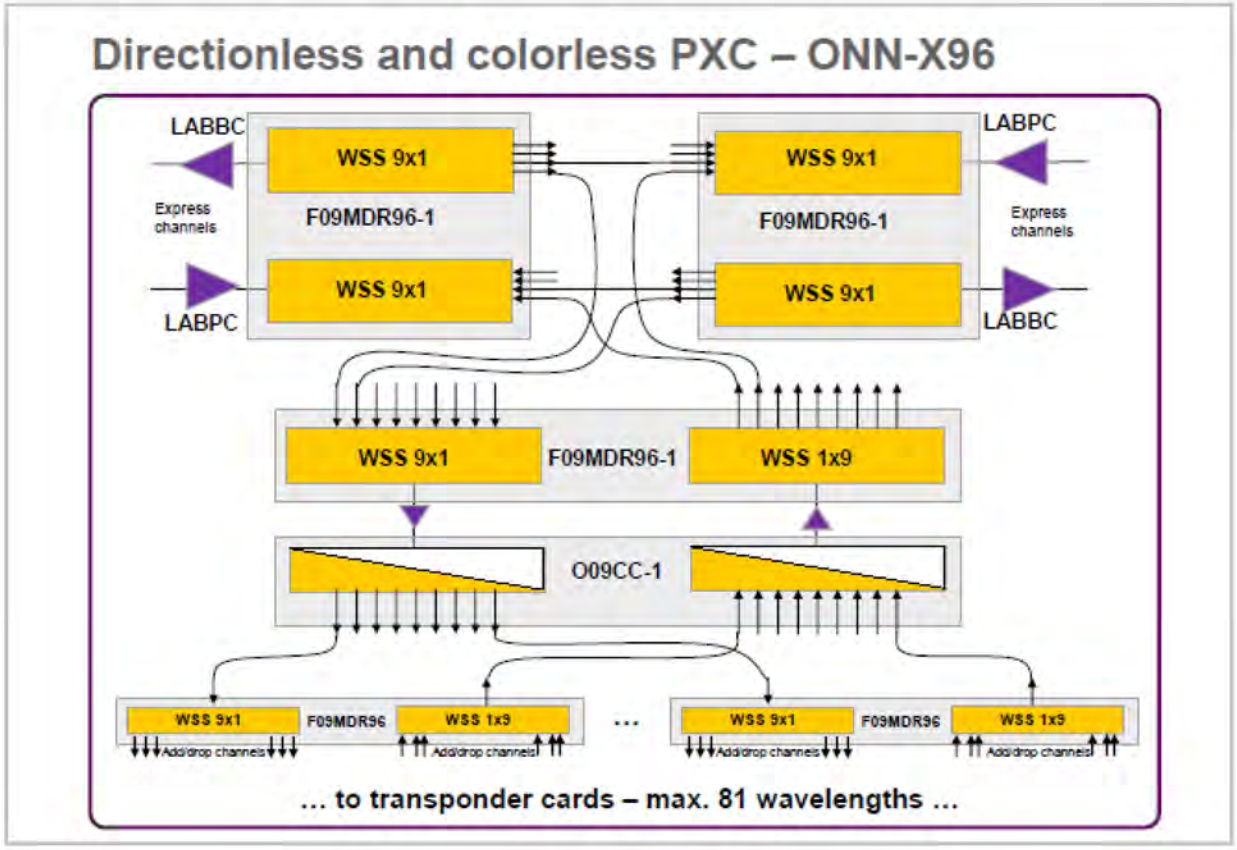
one or more other ports for second spectral channels;	Tellabs's ROADMs include one or more other ports for second spectral channels. As shown in Tellabs's ROADM Materials, Tellabs's ROADMs include a WSS-based switching module. The switching module includes one or more other ports for second spectral channels because the hiT 7300 is arranged in configurations that include multiple input ports, output ports, and pass through ports, and the spectral channels are directed among these ports at the individual wavelength level in any manner of arrangements as follows:


Directionless and colorless PXC – ONN-X96
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WSS 9x1
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F09MDR96-1
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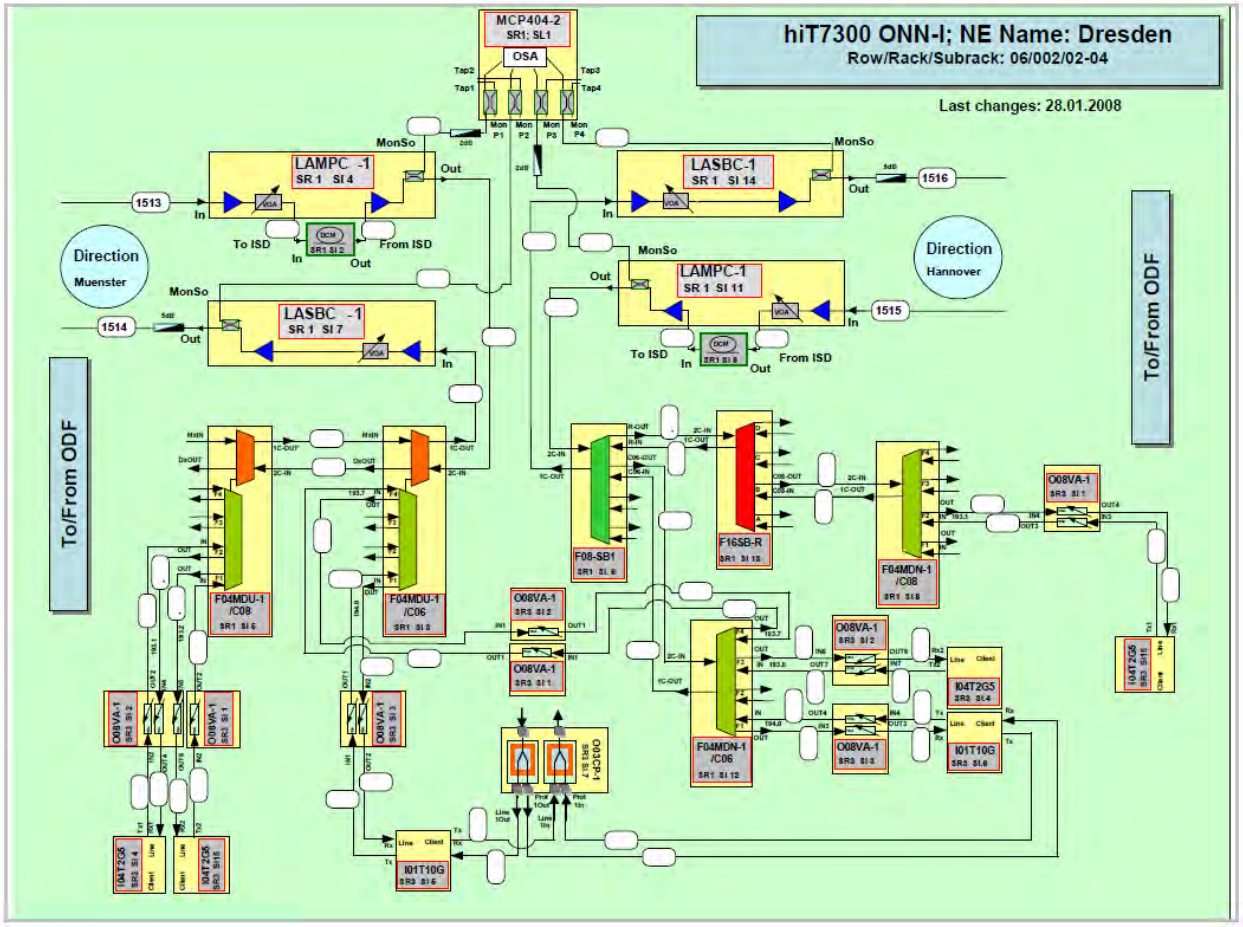
WSS 9x1
LABPC
WSS 9x1
Express channels
F09MDR96-1
WSS 9x1
LABBC
WSS 9x1
F09MDR96-1
WSS 1x9
O09CC-1
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
...
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
... to transponder cards – max. 81 wavelengths ...



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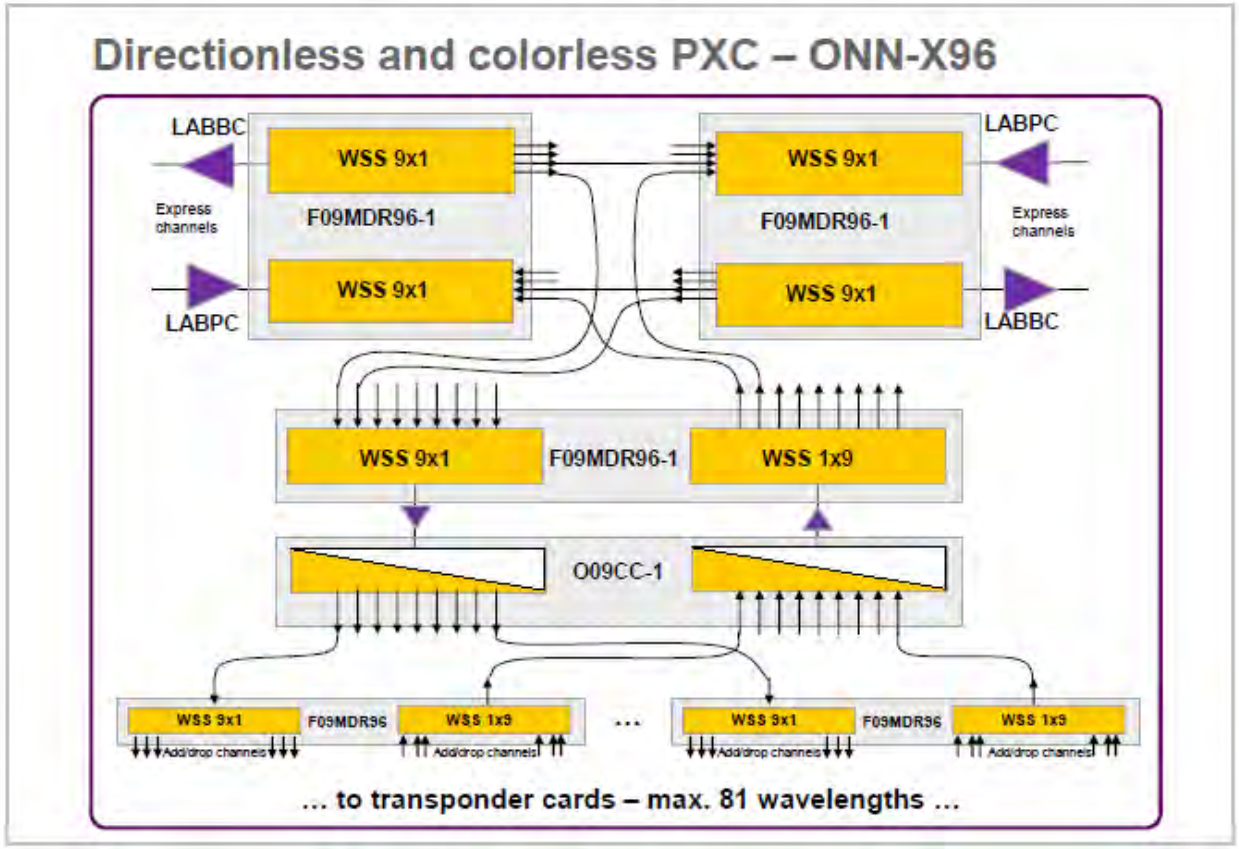
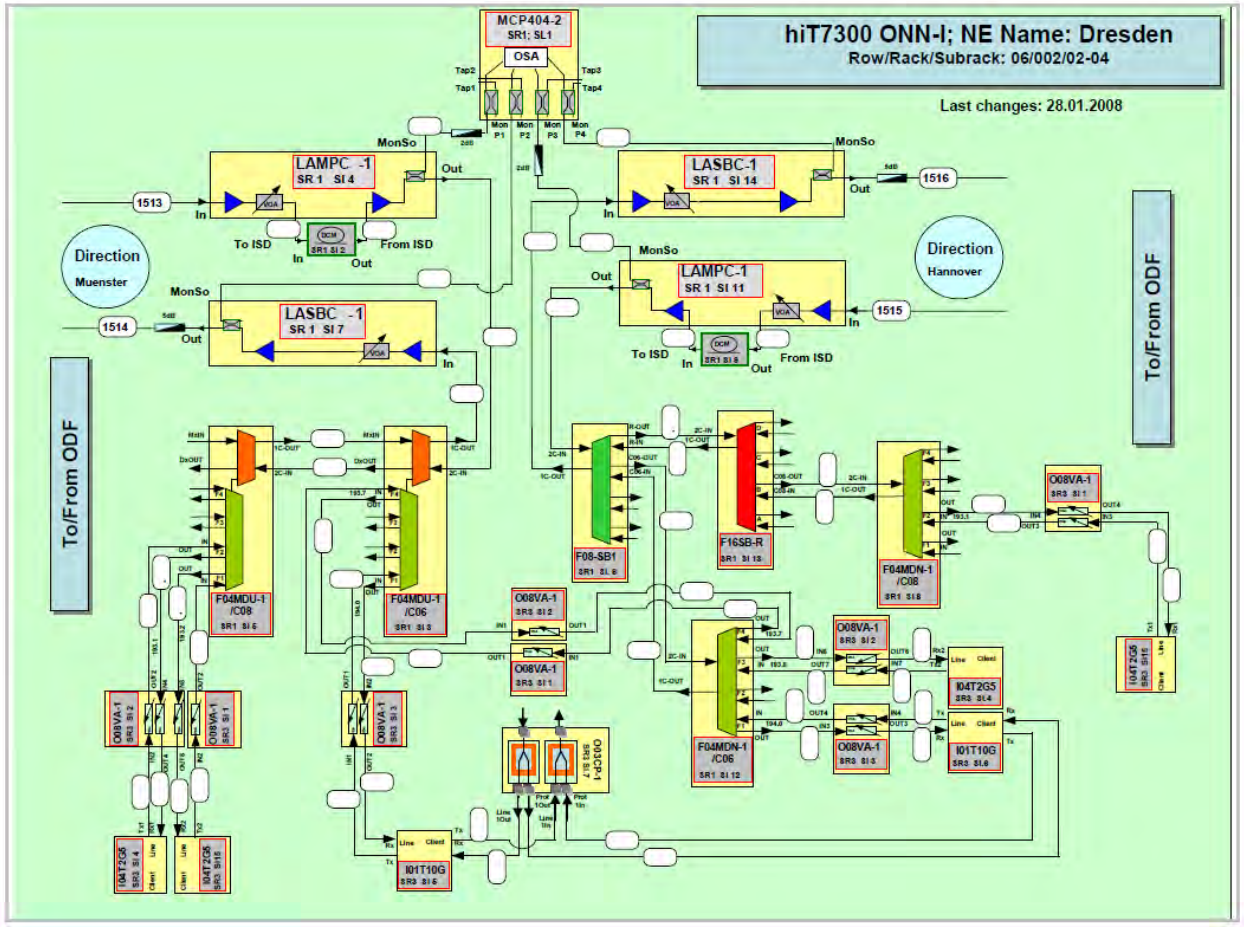
an output port for an output multi-wavelength optical signal;	Tellabs's ROADMs include an output port for an output multi-wavelength optical signal. According to Tellabs's Datasheet, Tellabs' ROADM necessarily includes an output port for an output multi-wavelength optical signal because the hiT 7300 is arranged in configurations that include multiple input ports, output ports, and pass through ports, and the spectral channels are directed among these ports at the individual wavelength level in any manner of arrangements as follows:


Directionless and colorless PXC – ONN-X96
LABBC
WSS 9x1
Express channels
F09MDR96-1
WSS 9x1
LABPC
LABPC
WSS 9x1
Express channels
F09MDR96-1
WSS 9x1
LABBC
WSS 9x1
F09MDR96-1
WSS 1x9
O09CC-1
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
...
WSS 9x1
F09MDR96
WSS 1x9
Add/drop channels
Add/drop channels
... to transponder cards – max. 81 wavelengths ...



According to Tellabs's Datasheet, the hiT 7300 has the following key features:

	SURPASS hiT 7300 key features • Comprehensive automation of commissioning, service provisioning and software upgrading • Customized network configuration and operation (customizable parameters and GUI) • Up to 40 channels, with optional extension to 80 channels, with a maximum 1,600 km reach at up to 40 Gbit/s per channel • Full range of client interfaces enabling Ethernet (GE, 10GE), SAN, TDM and OTH services • SNMP and TL-1 management interfaces • Ultra-flexible solutions for OADM, ROADM and PXC • OMS and channel protection • Enabled for ultra-long spans and hut skipping • Purely passive CWDM or DWDM applications • Remote network termination • Tunable laser transponder (full C-band) for fast provisioning of transparent end-to-end services and reduced spares cost • Remote access and highly effective automation: No system-specific know-how or laptop required for any on-site installation, commissioning, provisioning • "Flight recorder": Download all diagnostic data from NE with single mouse click for fast troubleshooting • Interactive online help for all network elements • Full G.709 implementation enables OTH functionality including end-to-end provisioning and management of wavelengths across multiple vendor sub-net-works • Standard ETSI/ANSI rack mounting (collocation applications are enabled) • NEBS3 compliant
a wavelength-selective device for spatially separating said spectral channels;	The Tellabs ROADMs include a wavelength-selective device for spatially separating said spectral channels. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a wavelength-selective device for spatially separating said spectral channels.
a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements	The Tellabs ROADMs include a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a spatial array of beam-deflecting elements positioned such that

being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.	each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Tellabs's Datasheet, the hiT 7300 has the following key features: **SURPASS hiT 7300 key features** • Comprehensive automation of commissioning, service provisioning and software upgrading • Customized network configuration and operation (customizable parameters and GUI) • Up to 40 channels, with optional extension to 80 channels, with a maximum 1,600 km reach at up to 40 Gbit/s per channel • Full range of client interfaces enabling Ethernet (GE, 10GE), SAN, TDM and OTH services • SNMP and TL-1 management interfaces • Ultra-flexible solutions for OADM, ROADM and PXC • OMS and channel protection • Enabled for ultra-long spans and hut skipping • Purely passive CWDM or DWDM applications • Remote network termination • Tunable laser transponder (full C-band) for fast provisioning of transparent end-to-end services and reduced spares cost • Remote access and highly effective automation: No system-specific know-how or laptop required for any on-site installation, commissioning, provisioning • "Flight recorder": Download all diagnostic data from NE with single mouse click for fast trouble-shooting • Interactive online help for all network elements • Full G.709 implementation enables OTH functionality including end-to-end provisioning and management of wavelengths across multiple vendor sub-net-works • Standard ETSI/ANSI rack mounting (collocation applications are enabled) • NEBS3 compliant According to Tellabs's Specifications, the hiT 7300 is remotely reconfigurable for optical switching at the individual wavelength level and each of the WSS cards capable of being used in the hiT 7300 allows for "remotely (via software) reconfigurable optical switching function per individual wavelength." According to Tellabs's Specifications, Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.

2. The optical add-drop apparatus of claim 1 further comprising a control unit for controlling each of said beam-deflecting elements.	The Tellabs ROADMs described in claim 1 further include a control unit for controlling each of said beam-deflecting elements. According to Tellabs's Datasheet, the hiT 7300 has the following key features: **SURPASS hiT 7300 key features** • Comprehensive automation of commissioning, service provisioning and software upgrading • Customized network configuration and operation (customizable parameters and GUI) • Up to 40 channels, with optional extension to 80 channels, with a maximum 1,600 km reach at up to 40 Gbit/s per channel • Full range of client interfaces enabling Ethernet (GE, 10GE), SAN, TDM and OTH services • SNMP and TL-1 management interfaces • Ultra-flexible solutions for OADM, ROADM and PXC • OMS and channel protection • Enabled for ultra-long spans and hut skipping • Purely passive CWDM or DWDM applications • Remote network termination • Tunable laser transponder (full C-band) for fast provisioning of transparent end-to-end services and reduced spares cost • Remote access and highly effective automation: No system-specific know-how or laptop required for any on-site installation, commissioning, provisioning • "Flight recorder": Download all diagnostic data from NE with single mouse click for fast trouble-shooting • Interactive online help for all network elements • Full G.709 implementation enables OTH functionality including end-to-end provisioning and management of wavelengths across multiple vendor sub-net-works • Standard ETSI/ANSI rack mounting (collocation applications are enabled) • NEBS3 compliant According to Tellabs's Specifications, the hiT 7300 is remotely reconfigurable for optical switching at the individual wavelength level and each of the WSS cards capable of being used in the hiT 7300 allows for "remotely (via software) reconfigurable optical switching function per individual wavelength." According to Tellabs's Specifications, the hiT 7300 has channel power monitors as follows:

2.7.13 Channel power monitor (MCP4x-x) card

The channel power monitor card MCP4x-x provides an in-service monitoring of the optical channel power levels. The card contains an Optical Spectrum Analyzer (OSA) for 40/80 channels, which is periodically connected to 4 optical input ports.

There is three different types of the channel power monitor card are available:

Card name	Supported bit rates	Usage
MCP404-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP404-2	2.5 Gbit/s; 10 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP4-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	80 channels (within 50 GHz grid) monitoring

The MCP4x-x card is used for:

- In-service measurement of optical channel power levels of the 40 channels on a 100 GHz grid at the source monitoring output port which is used for all optical amplifier card types as well as for the OSC termination card (LIFB-1).
- Measurement of an automated enhanced pre-emphasis configuration on an optical pre-emphasis section (i.e., a link with full channel multiplexing/demultiplexing). Using MCP4xx-x card at the beginning and end of a link in combination with an attenuator card, provides a fully automated optical link commissioning and an in service channel upgrade.
- Measurement of an automatic in-service amplifier tilt control. Using MCP4xx-x card at the beginning and end of a link, allows tilt correction values to be distributed over the whole link.
- Automatic performance measurement and supervision of optical carriers with autonomous start of measurement cycle every 300 seconds.

According to Tellabs's Specifications, Tellabs's ROADMs use at least a MEMs mirror array in the WSSs

	of the ROADMs.

322421555.1

Claim 12 of U.S. Patent No. RE42,678
v.
Coriant Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. A wavelength-separating-routing apparatus, comprising:	Coriant makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Coriant is a successor company to Nokia Siemens Optical GmbH ("Nokia Siemens") and to its ROADMs – the hiT7300 or SURPASS hiT 7300. *See* http://en.wikipedia.org/wiki/Coriant; http://www.lightreading.com/coriant-separates-from-nsn/d/d-id/702535; http://www.lightwaveonline.com/articles/2013/03/ex-nsn-optical-division-anticipates-new-start-as-coriant.html. Several documents detail the functionality of Coriant's ROADM products, including: • "Hardware and Functionality" documenting the features of the SURPASS 7300 ROADM, from Nokia Siemens, dated 2011 ("Specifications"); • "Datasheet: SURPASS hiT 7300, Next-Generation Nulti-Haul DWDM Platform," from Nokia Siemens, dated 2007 ("Datasheet"); and • information and documents available from Coriant's website (http://www.coriant.com/products/hit7300.asp) ("Website") (collectively, ROADM Materials"). According to Coriant's Specifications, the hiT 7300 uses wavelength selective switches ("WSS") as follows:

2.2.3 Wavelength-Selective Switch Cards

The filter cards act as multiplexers/demultiplexers by providing the primary wave division or aggregation of all the transponder signals and allowing access (add/drop) to a particular set of wavelengths from an optical fiber while passing the remaining wavelengths. Line side wavelengths require translation to client side equipment via the transponder card.

The following Wavelength-Selective Switch cards are supported in hiT 7300:

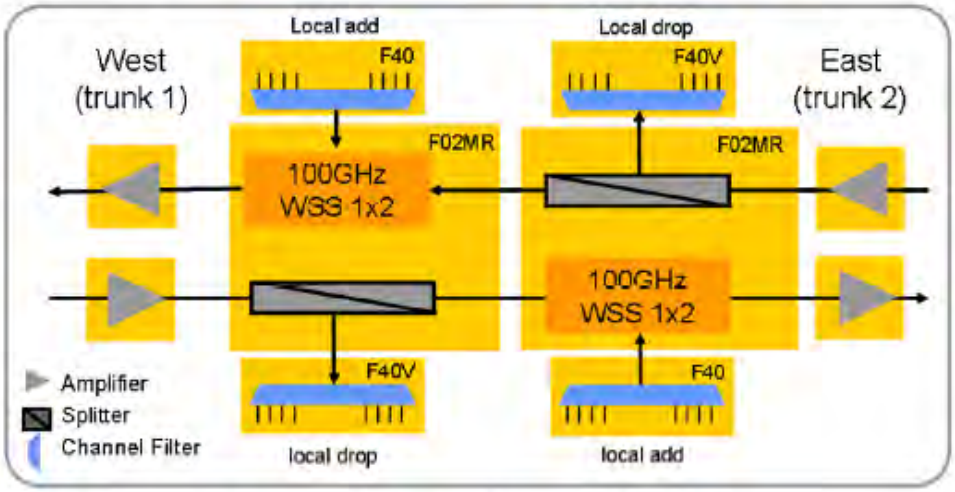
Wavelength-Selective Switch Cards			
Card name	**Usage** Optical multiplexer of	**Architecture**	**Communication type**
F40MR-1	a ROADM	PLC-WSS	Bidirectional
F02MR-1	an ONN-R2	MEMS-WSS	Bidirectional
F08MR-1	reconfigurable PXC	MEMS-WSS	Bidirectional
F06DR80-1	Optical demultiplexer of a reconfigurable PXC	MEMS-WSS	Unidirectional
F06MR80-1	a reconfigurable PXC	MEMS-WSS	Unidirectional
F09DR80-1	Optical demultiplexer of a reconfigurable PXC	PLC-WSS	Unidirectional
F09MR80-1	a reconfigurable PXC	PLC-WSS	Unidirectional
F09MDRT-1/S	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDRT-1/O	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDR96-1	an ONN-X96	Tunable WSS	Bidirectional
O09CC-1	an ONN-X96	Coupler card for color- and directionless PXC	Bidirectional
F80DCI-1	Optical demultiplexer of a ROADM	Interleaver filter and splitter	Unidirectional
F80MDI-1	Optical multiplexer or demultiplexer	Interleaver filters	Bidirectional

	According to Coriant's Specifications, the hiT 7300 operates with various WSS cards as follows: 2.2.3.1 F40MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a ROADM providing full access to 40 optical channels. The key component for this application is the F40MR-1 card which includes an integrated Planar Lightwave Circuit-Wavelength Selective Switch (PLC-WSS) with low insertion loss, providing a remotely (via software) reconfigurable optical switching function per individual wavelength. 2.2.3.2 F02MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a cost optimized nodal degree 2 ROADM (i.e., ONN-R2) providing full access to 40 optical channels. The key component for this application is the F02MR-1 card which includes in the transmission path an integrated 2:1 Micro-Electro-Mechanical System - Wavelength Selective Switch (MEMS-WSS) module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

	2.2.3.3 F08MR-1 SURPASS hiT 7300 supports wavelength selective switching for building a multi-degree 40-channel PXC providing full access to 40 optical channels. The key component for this application is the F08MR-1 card which includes an integrated 8:1 MEMS-WSS module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength. The input DWDM signal from the line interface (optical pre-amplifier) is split into 7 crossconnect outputs and 1 local drop traffic output. The drop output also provides an optical input power monitor for detection of Loss Of Signal (LOS) and laser safety control. The **WSS module** collects DWDM traffic from 7 other line ports and 1 local add traffic input, and performs arbitrary pass-through switching for any wavelength, of the 8 input ports, toward its output port. The internal cross-connect traffic ports from different F08MR-1 cards (of different line directions) can be interconnected to allow a configurable pass-through traffic between arbitrary line directions.

	2.2.4.2 ONN-R2 with F02MR-1 - Wavelength-Selective Switch (WSS) Card The F02MR is a cost optimized alternative to the F40MR card. It includes an integrated MEMS WSS based wavelength selective switch (MEMS-WSS) with low insertion loss, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. In the Tx path, the key component of this card is the integrated MEMS based 2:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via NMS) reconfigurable optical switching function per individual wavelength. The incoming signals of the cross-connect are switched with the WSS module on the common output which is followed by a booster amplifier. One of the inputs of the WSS is connected to the output of a mux filter where the local add channels are inserted. In the RX path, the incoming signal from the pre-amplifier is launched into a 1x2 splitter with a 40/60 splitting ratio. At the higher output port, a demux filter (F40/S) can be connected for local drop traffic. The other port is the output of the cross-connect. At both inputs of the WSS and the C-COM port of the splitter, LOS monitors are used for supervision. Also a power monitor is present at the splitter drop output.

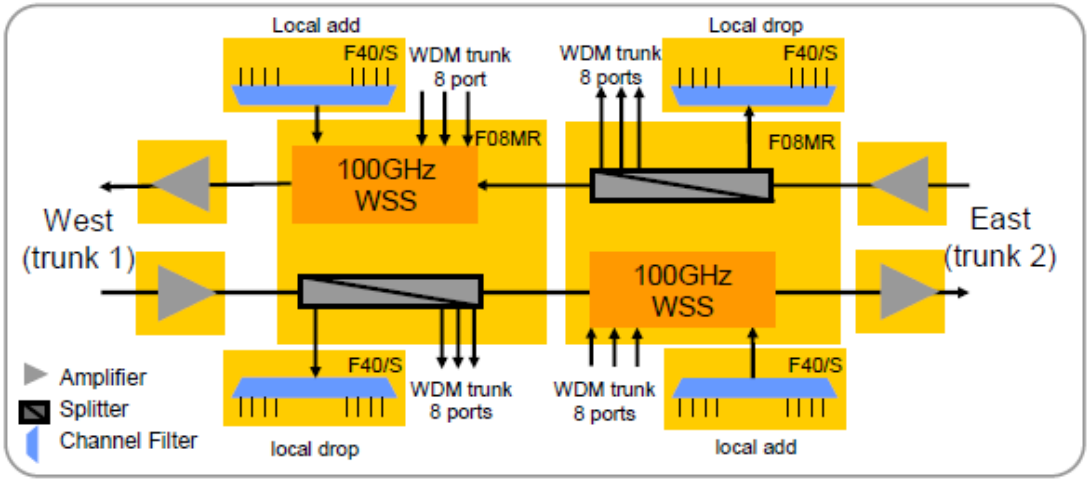
ROADM architecture for 40 channels, ONN-R2



- Nodal degree 1..2, in-service upgrade from terminal to ROADM
- Alternatively: F40MR based on PLC technology can be used with integrated VOAs, channel power monitors, and local add filters
- East-west separation per design
- support of patch through on drop side to ROADM node in 2nd ring (ring interconnect)

	2.2.4.3 ONN-X with F08MR card 40-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS) The F08MR card which includes an integrated MEMS based 8:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is optically splitted into 7 cross-connect outputs and 1 local drop traffic output, where the drop output also provides an optical input power monitor for detection of loss-of-signal and laser safety control. The WSS module collects DWDM traffic from 7 other line ports and 1 local add traffic input and performs arbitrary pass-through switching for any wavelengths from any input of its 8 input ports towards its output port. The internal cross-connect traffic ports from different F08MR cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS unit supports hitless wavelength switching for any unchanged optical channel interconnections.

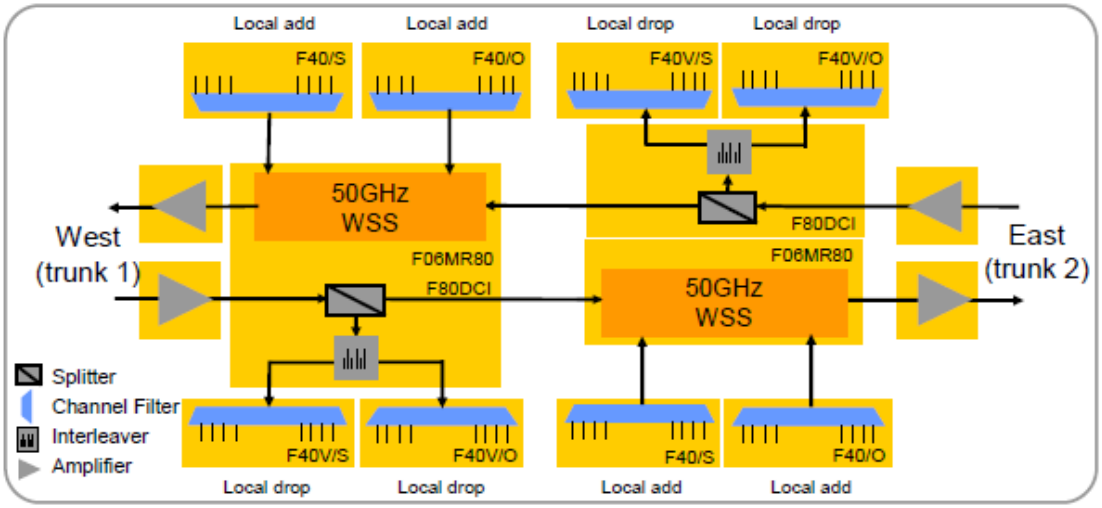
Photonic Cross Connect (PXC) for 40 channels



- PXC, supporting nodal degree 8
- one WSS for channels add and one splitter for channel drop per nodal degree
- fully remotely configurable
- east-west separation
- (only two degree shown in figure)

	2.2.4.5 ONN-X with F0xDR80 and the F0xMR80 cards (80-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS)) The F0xDR80 and the F0xMR80 cards each including an integrated MEMS based 1:6 (6:1) or 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F0xDR80 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 40-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M. The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F0xMR80 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 40-channel frequency groups of standard grid and offset grid. The internal cross-connect traffic ports from F0xDR80 and F0xMR80 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.

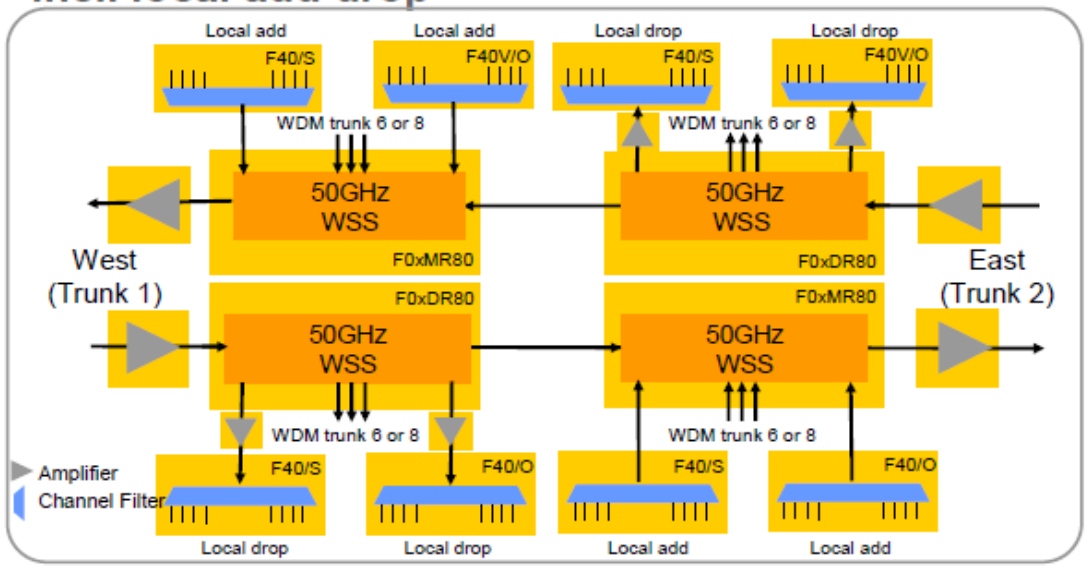
Remotely configurable ROADM – 80 channels



- Nodal degree 2, in-service upgrade from terminal to ROADM
- Power monitoring per channel via one MCP card
- East-west separation per design

For internal use

PXC with double WSS structure for 80 channels incl. local add drop

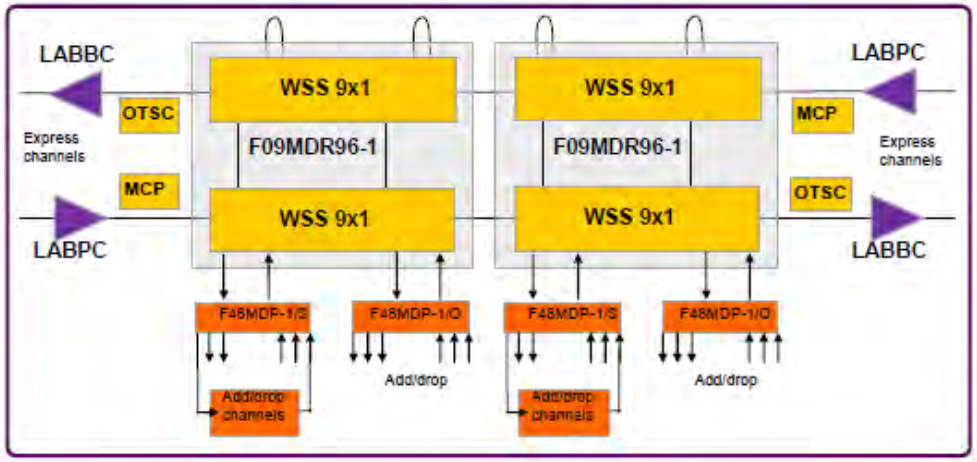


- Nodal degree 5 or 8, plus local add/drop
- Drop amplifiers (type LAS) for increased power budget and reach
- (only two directions shown in figure)

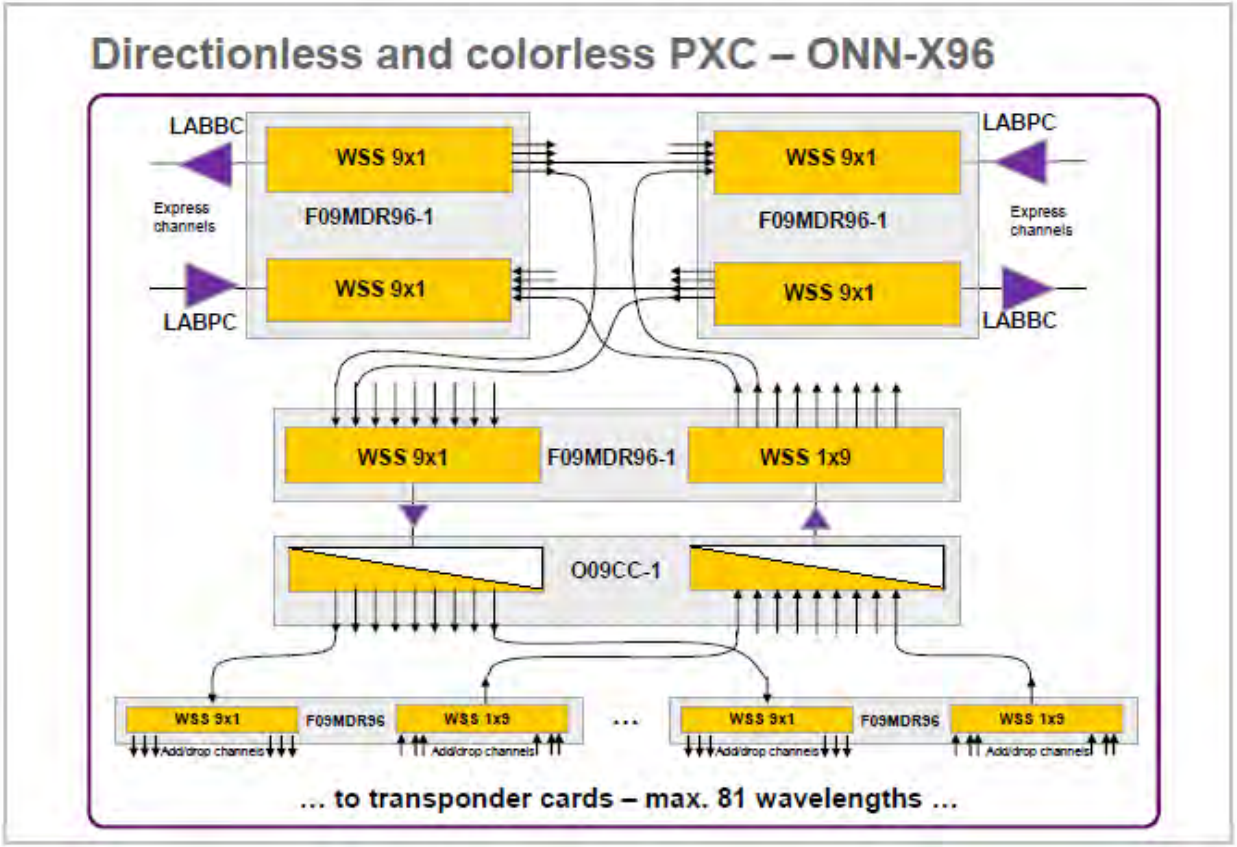
For internal use

	2.2.4.6 ONN-X96 with F09MDR96-1 cards (MEMS-WSS)) The F09MDR96-1 card include an integrated MEMS based 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength. The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F09MDR96-1 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 48-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M. The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F09MDR96-1 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 48-channel frequency groups of standard grid and offset grid. The internal cross-connect traffic ports from F09MDR96-1 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions. The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.

Photonic cross connect PXC – 96 channels



- Nodal degree 1 up to 8, in-service upgrade from terminal to PXC
- Power monitoring per channel MCP card
- East-west separation per design



According to Coriant's Specifications, the hiT 7300 has channel power monitors as follows:

2.7.13 Channel power monitor (MCP4x-x) card

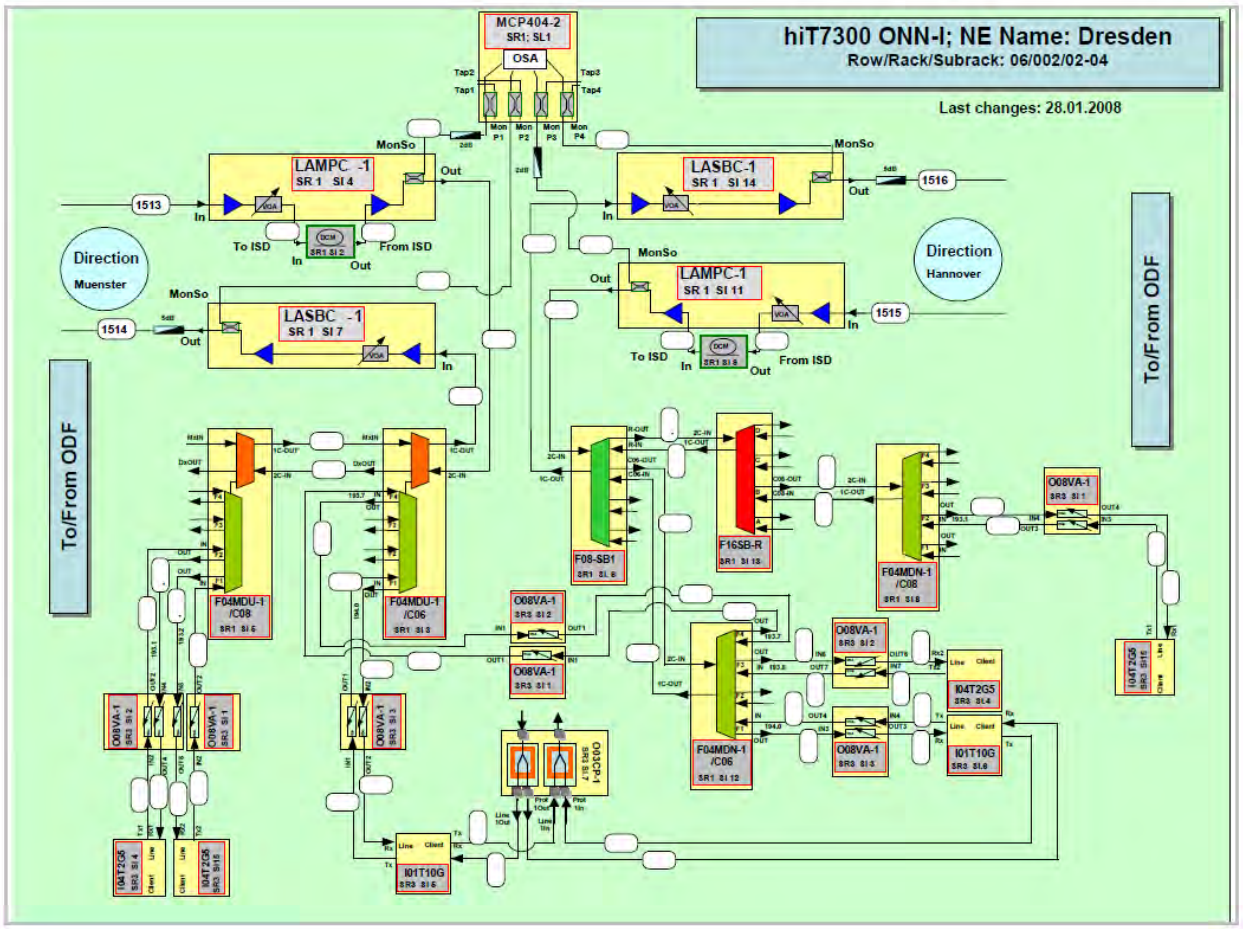
The channel power monitor card MCP4x-x provides an in-service monitoring of the optical channel power levels. The card contains an Optical Spectrum Analyzer (OSA) for 40/80 channels, which is periodically connected to 4 optical input ports.

There is three different types of the channel power monitor card are available:

Card name	Supported bit rates	Usage
MCP404-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP404-2	2.5 Gbit/s; 10 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP4-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	80 channels (within 50 GHz grid) monitoring

The MCP4x-x card is used for:

- In-service measurement of optical channel power levels of the 40 channels on a 100 GHz grid at the source monitoring output port which is used for all optical amplifier card types as well as for the OSC termination card (LIFB-1).
- Measurement of an automated enhanced pre-emphasis configuration on an optical pre-emphasis section (i.e., a link with full channel multiplexing/demultiplexing). Using MCP4xx-x card at the beginning and end of a link in combination with an attenuator card, provides a fully automated optical link commissioning and an in service channel upgrade.
- Measurement of an automatic in-service amplifier tilt control. Using MCP4xx-x card at the beginning and end of a link, allows tilt correction values to be distributed over the whole link.
- Automatic performance measurement and supervision of optical carriers with autonomous start of measurement cycle every 300 seconds.

	According to Coriant's Specifications, the hiT 7300 is in configurations that include multiple input ports, output ports, and pass through ports, and the spectral channels are directed among these ports at the individual wavelength level in any manner of arrangements as follows:  According to Coriant's Datasheet, the hiT 7300 has the following key features:

	SURPASS hiT 7300 key features • Comprehensive automation of commissioning, service provisioning and software upgrading • Customized network configuration and operation (customizable parameters and GUI) • Up to 40 channels, with optional extension to 80 channels, with a maximum 1,600 km reach at up to 40 Gbit/s per channel • Full range of client interfaces enabling Ethernet (GE, 10GE), SAN, TDM and OTH services • SNMP and TL-1 management interfaces • Ultra-flexible solutions for OADM, ROADM and PXC • OMS and channel protection • Enabled for ultra-long spans and hut skipping • Purely passive CWDM or DWDM applications • Remote network termination • Tunable laser transponder (full C-band) for fast provisioning of transparent end-to-end services and reduced spares cost • Remote access and highly effective automation: No system-specific know-how or laptop required for any on-site installation, commissioning, provisioning • "Flight recorder": Download all diagnostic data from NE with single mouse click for fast troubleshooting • Interactive online help for all network elements • Full G.709 implementation enables OTH functionality including end-to-end provisioning and management of wavelengths across multiple vendor sub-net-works • Standard ETSI/ANSI rack mounting (collocation applications are enabled) • NEBS3 compliant
a) multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports;	The Coriant ROADMs include multiple fiber collimators, providing an input port for a multi -wavelength optical signal and a plurality of output ports. According to Coriant's ROADM Materials, Coriant's ROADM products include a WSS-based switching module ("switching module"). The switching module includes multiple fiber collimators, providing an input for multi-wavelength optical signal and a plurality of output ports.
b) a wavelength-separator, for separating said multi-wavelength optical signal from said input port into multiple spectral channels;	The Coriant ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Coriant's ROADM Materials, Coriant's ROADM products include a WSS-based switching module. The switching module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels.

c) a beam-focuser, for focusing said spectral channels into corresponding spectral spots; and	The Coriant ROADMs include a beam-focuser, for focusing said spectral channels into corresponding spectral spots. According to Coriant's ROADM Materials, Coriant's ROADM products include a WSS-based switching module. The switching module includes a beam-focuser, for focusing said spectral channels into corresponding spectral spots.
d) a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports.	The Coriant ROADMs include a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Coriant's ROADM Materials, Coriant's ROADM products include a WSS-based switching module. The switching module includes a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Coriant's Specifications, Coriant's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.
12. The wavelength-separating-routing apparatus of claim 1 wherein each channel micro-mirror is a silicon micromachined mirror.	The channel micromirrors of the ROADMs described in claim 1 are silicon micromachined mirrors. Coriant ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include silicon micromachined mirrors.

Claims 7, 8 and 13 of U.S. Patent No. RE42,368
v.
Fujitsu Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. An optical add-drop apparatus comprising:	Fujitsu makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Fujitsu's ROADM products, including: • "Flashwave 9500 Packet Optical Networking Platform," from Fujitsu Network Communictions Inc., dated July 2010, available from us.fujitsu.com/telecom ("Flashwave Datasheet"); • "Flashwave 9500 Packet Optical Networking Platform," from Fujitsu Network Communictions Inc., dated March 2014, available from www.fujitsu.com/downloads/TEL/fnc/datasheets/flashwave9500.pdf ("Flashwave Datasheet 2") • "Optical Components and Devices for Next-Generation Photonic Networks," by M. Kawai, K. Mori, T. Yamamoto, O. Tsuboi, K. Tanaka, K. Morito, I. Sawaki, and M. Suguwara, dated July 10, 2006, published in Fujitsu Sci. Tech. J. 42.4, pp. 483-93 (October 2006); • "Fujitsu's Third-Generation Optical Transport Solution for Metro Optical Networks: Flashwave 7500," by H. Matsumoto, H. Iino, S. Carlton, dated April 10, 2006, published in Fujitsu Sci. Tech. J. 42.4, pp. 460-68 (October 2006) ("Flashwave Paper"); • "Unit Descriptions, Flashwave 7500, Release 5.2, Issue 1, April 2008," from Fujitsu Network Communications Inc., dated April 2008 ("Flashwave Unit Description"); • "Optical Burst Switches," by T. Yamamoto, from Fujitsu Limited and Fujitsu Laboratories Limited, dated 2006 ("Fujitsu Powerpoint"); • "Fujitsu Powered Video on Demand Solutions," from Fujitsu Network Commmunications Inc., dated 2005 ("VOD Paper"); and • Information and documents available from Fujitsu's website (www.fujitsu.com), specifically the pages describing Fujitsu's Flashwave 7500 (www.fujitsu.com/us/services/telecom/products/flashwave-7500.html) and Fujitsu's Flashwave 9500 (www.fujitsu.com/us/services/telecom/products/flashwave-9500.html) ("Website") (collectively, the "Fujitsu ROADM Materials"). According to Fujitsu's Flashwave Paper: "Fujitsu has chosen a device called a wavelength selectable switch (WSS) as the core of its next generation products. This device improves on the switch fabric in second-generation systems. The WSS performs the traditional switching and also performs channel power balancing and can switch traffic between multiple rings. This device enables new network configurations such as hubs and meshes, which gives network planners a high degree of flexibility. "Another dramatic new development in optical communications is the use of lasers that can be tuned across the full range of

	wavelengths, allowing users to dynamically reconfigure wavelengths within a system. The WSS has the unique ability to allow any input port to accept or drop any wavelength (each port in a typical second-generation system is dedicated to a specific wavelength). When full-band tunable lasers are used with the WSS, a line card can operate at any wavelength. This greatly improves the time to market for new services and simplifies network planning. Fujitsu has coined the term "dynamic optical add-drop multiplexer (DOADM) to describe this configuration. [Note – a "DOADM" is equivalent to a "ROADM."]." "[A] WSS element can drop wavelengths to any of multiple paths. If all the wavelengths cannot be supported by a single WSS card, more WSS cards can be daisy chained to further separate the wavelengths until each one exist a single fiber. The advantage of using WSSs is that any wavelength can be directed to any output fiber. This mode of operation is called colorless because output ports are not associated with a particular wavelength or color. ... "Through traffic enters a WSS element, and wavelengths that were dropped and should not continue are blocked from the output fiber. The mirrors in a WSS position wavelengths passing through the node to the output fiber. Other wavelengths are added via transponder cards through add-port fibers on the WSS and are also directed to the output fiber. In this way, through traffic and add traffic are multiplexed together and then amplified and output from the node." According to Fujitsu's Flashwave Paper, the following diagram depicts the operation of Fujitsu's Flashwave ROADM (aka DOADM) devices:

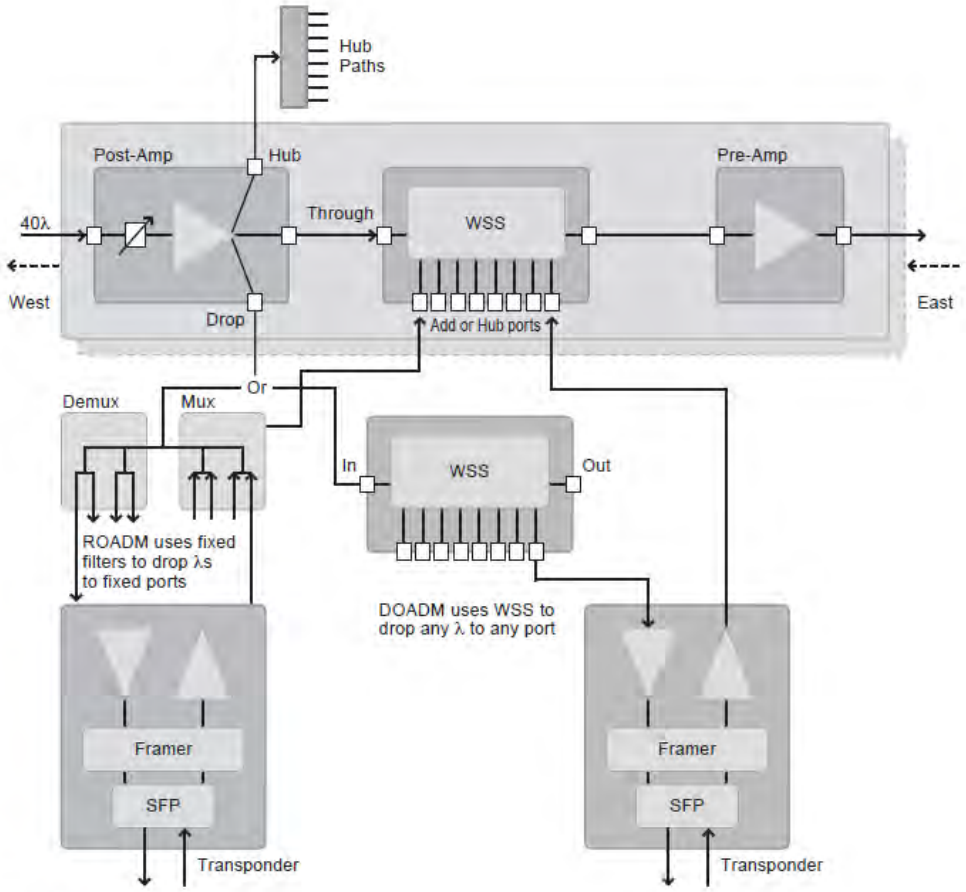


Figure 3
FLASHWAVE architecture.

(Flashwave Paper, Figure 3, p. 465)

According to Fujitsu's Website, Fujitsu describes the functionality of its ROADMs, which include WSSs, as follows:

"FLASHWAVE 7500 Metro/Regional Multiservice ROADM: The FLASHWAVE 7500 optical transport system is the global superhighway for flexible high bandwidth service delivery. It offers the most advanced DWDM, Optical hubbing, ROADM, and

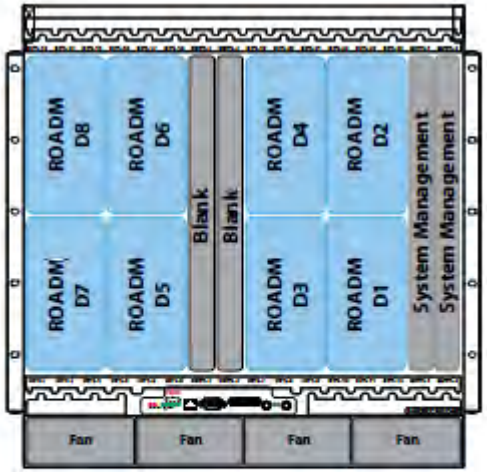
	network design capabilities to deliver and manage growing metro and regional networks. The system supports both ANSI and ETSI-certified solutions, along with different configurations to optimize your metro and regional network infrastructures. • DWDM Optical Hubbing • 10 Gbps and 40 Gbps fully tunable DWDM wavelengths • G.709 OTN interfaces, including MSPP-on-a-card • Advanced functions for operational simplification • Complete network automation from design to management "Advanced Wavelength Selective Switch: The optical core of this Dense Wavelength Division Multiplexing (DWDM) platform is based on an advanced Wavelength Selective Switch (WSS). This delivers the most flexible wavelength routing and topology available today. The platform enables optical mesh architectures, with which metro and regional carriers are shaping the DWDM transport network of the future. It also integrates optical multiplexer/demultiplexer, variable optical attenuation and a Micro Electrical Mechanical System (MEMS)-based optical switch into a single component. The WSS removes the need for fiber jumpers when adding or dropping wavelengths. Overall, the capabilities of the FLASHWAVE 7500 system allow drastic reductions in both CAPEX and OPEX. "Flexible, Modular Architecture: The FLASHWAVE 7500 Metro/Regional Multiservice ROADM is an economical and sophisticated solution for today's metro and regional bandwidth requirements for up to 40 wavelengths, 24 nodes and 1000 km in distance. Remote software provisioning and sophisticated self-tuning features allow rapid service activation. Advanced optical line cards provide efficient on-ramps to a fully photonic backbone, delivering key business services such as Video on Demand (VoD), residential high-speed Internet access and enterprise data services across metro and regional networks up to 1000 kilometers. "Over the past seven years, WDM networks have evolved from simple point-to-point systems to single-ring networks to advanced interconnected mesh architectures. Reconfigurable Optical Add/Drop Multiplexers (ROADMs) are the key network element enabling these advanced networks, along with a key technology component called a Wavelength Selective Switch (WSS)." "Fujitsu was the first vendor to develop and deploy ROADM technology in 2003, and the first to incorporate a WSS-based optical switch fabric. Fujitsu remains the global industry leader in metro/regional ROADM technology and solutions. "Prior to ROADMs, DWDM systems were commonly implemented using "fixed filters" in what is known as a "banded" DWDM architecture. A typical banded DWDM system provided 32 channels in eight groups of four channels in each group. Banded DWDM systems, like the Fujitsu FLASHWAVE 7420, remain popular for many access WDM and price-sensitive applications. ROADMS offer additional size, flexibility, and performance benefits, including: • Improved network utilization due to single-channel granularity • Non-block access to any lambda – improved network efficiency • Flexibility & service velocity – drop any channel and any number of channels at any site

	• Integrated auto-power balancing, eliminating costly & timely manual tuning • Full band tunable transponders • Support for interconnected ring and mesh architectures • A-Z end-to-end wavelength provisioning "The keys to any ROADM are the optical switch fabric and optical switching technology. Fujitsu employs an advanced Wavelength Selective Switch (WSS) module as our optical switching "engine." The WSS provides wavelength selection, switching, power monitoring, and auto-power balancing all within a single device. In addition, the WSS allows Fujitsu ROADMS to support advanced network architectures such as multidegree hub nodes and mesh architectures." According to Fujitsu's Website, Fujitsu's Flashwave 9500 product contains a ROADM: "The FLASHWAVE 9500 is the definitive Packet ONP. Its unique hardware and software architecture integrates Ethernet, ROADM and SONET/SDH technology in a single shelf that drives cost out of today's metro network. As high-bandwidth, high-quality multimedia packet-centric services dominate, service providers can deploy the FLASHWAVE 9500 platform to enjoy the cost and manageability that optical networking has always provided. "The FLASHWAVE 9500 Packet ONP solution family is designed to consist of common interface cards and system software across a variety of configurations, traffic capacity ranges, and entry prices allowing service providers to cost-optimize their network. • Purpose-built modular design • Fujitsu patent-pending universal TDM/Packet fabric • MPLS-based connection-oriented Ethernet transport technology to deliver private-line quality Ethernet aggregation and connectivity services • Integrated ROADM technology to deliver bulk bandwidth economically and with operational simplicity • Next-generation SONET/SDH technology to support the full range of network services while retaining operational continuity with existing networks • High density multiservice, multirate TDM interfaces • A full 40G-ready ROADM in one-quarter of a shelf • 480G of SONET/SDH or packet bandwidth in only one-third of a rack" According to Fujitsu's Flashwave Datasheet, Fujitsu's ROADM functions include: • "High-density 8-degree ROADM configuration in a single 13 RU shelf • 8-degree x 88-channel Wavelength Selectable Switch (WSS) • Operator-selectable ITU-T wavelengths support 50 GHz ITU-T grid • ROADM full-band tunable interface units o 10G universal transponder

- 40G transponder
- 8-port multirate muxponder

- 10G/40G wavelength support – 100G ready
- Automatic level and gain control (No manual attenuation)
- Per-channel optical channel monitoring
- Operator-tunable dispersion compensation
- Narrowband direct connect
- SONET SDCC and OTN GCC support
- OCh-DPRING optical protection
- Operator-configurable Forward Error Correction options (FEC or EFEC)"

According to Fujitsu's Flashwave Datasheet, Fujitsu's Flashwave products incorporate ROADMs as follows:



ROADM Configuration
8-degree – 88-channel ROADM
Multishelf support for service interfaces
10G/40G wavelength support
100G hardware ready

(Flashwave Datasheet, p. 7)

	According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave products include a ROADM: "The FLASHWAVE 9500 Packet ONP delivers ROADM, OTN, Ethernet and TDM technologies for deploying optical ring, mesh, and linear add/drop topologies with 99.999% service availability. All plug-in cards, fans and chassis power distribution are designed for resilient operation with no single point of failure. The modular architecture enables carriers to select configurations for specific applications, whether ROADM-only, aggregation-only, or combinations of service aggregation and WDM on a single network element. The FLASHWAVE 9500 system reduces footprint, capital/operational expenses, and complexity by collapsing multiple technologies and network layers into a single, easy-to-use, modular platform." "High-Density 88-Channel Pluggable ROADM: The 88-channel pluggable ROADM provides per-channel add/drop capability. This offers flexibility and capacity scaling that enables service providers to address metro, regional and core networks now and into the future. The central switch fabric optimizes the ROADM technology through sub-wavelength grooming and aggregation. The flexibility of the ROADM allows a mix of services transported over 10G, 40G, 100G and future 400G rates onto any of the 88 channels. The FLASHWAVE 9500 system offers up to a 12-degree optical multi-TID hub for mesh network wavelength mapping. This higher density optical hub increases network interconnect capability while reducing transponder requirements through direct WSS interconnect between collocated network elements." "System Capacity • 960 Gbps non-blocking SONET/SDH grooming • 1.2 Tbps non-blocking packet grooming • 2.4 Tbps OTN switch fabric w/ODU0, 1, 2, 2e, 3, 4 and ODU flex grooming • 20 Gbps non-blocking VT grooming • Up to 8 degrees of ROADM connectivity • 88 x 10 Gbps/40 Gbps/100 Gbps wavelengths per ROADM degree • Universal interface slots o SDS shelf: 16 o HDS shelf: 24" "ROADM Functions: • Asymetric multi-TID 12-degree hub • High-density 8-degree ROADM configuration in a single shelf or distributed across multiple shelves (split-hub ROADM) • 8-degree x 88-channel Wavelength Selectable Switch (WSS) • Operator-selectable ITU-T wavelengths support 50 GHz ITU-T grid • ROADM full-band tunable interface units o 10G universal transponder o 40G transponder o 12-port multirate muxponder o 100G transponder/muxponder

- 10G/40G/100G wavelength support
- Per-channel optical channel monitoring
- Narrowband direct connect
- SONET SDCC and OTN GCC support
- OCh-DPRING optical protection

According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave product is a ROADM:

(Flashwave Datasheet 2, p. 2)

According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave products provide ROADM-based transport and service delivery:

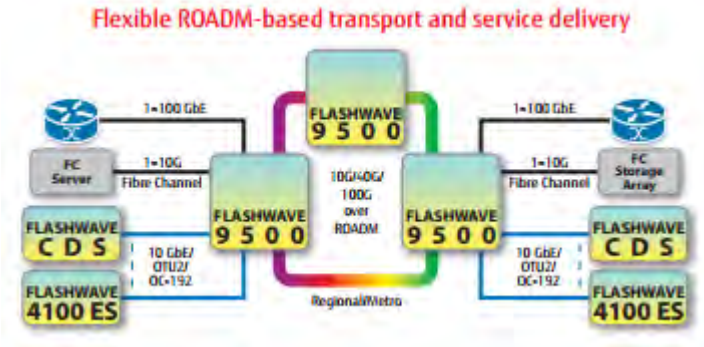
	 (Flashwave Datasheet 2, p. 2) According to Fijitsu's Flashwave Unit Description, Fujitsu sells a "2D-ROADM Unit" depicted in the figure below, which shows the input and output ports in the ROADM unit:

Figure 8-7 [p. 8-25] shows the 2D-ROADM plug-in unit (SFMA-RDC1) front panel.

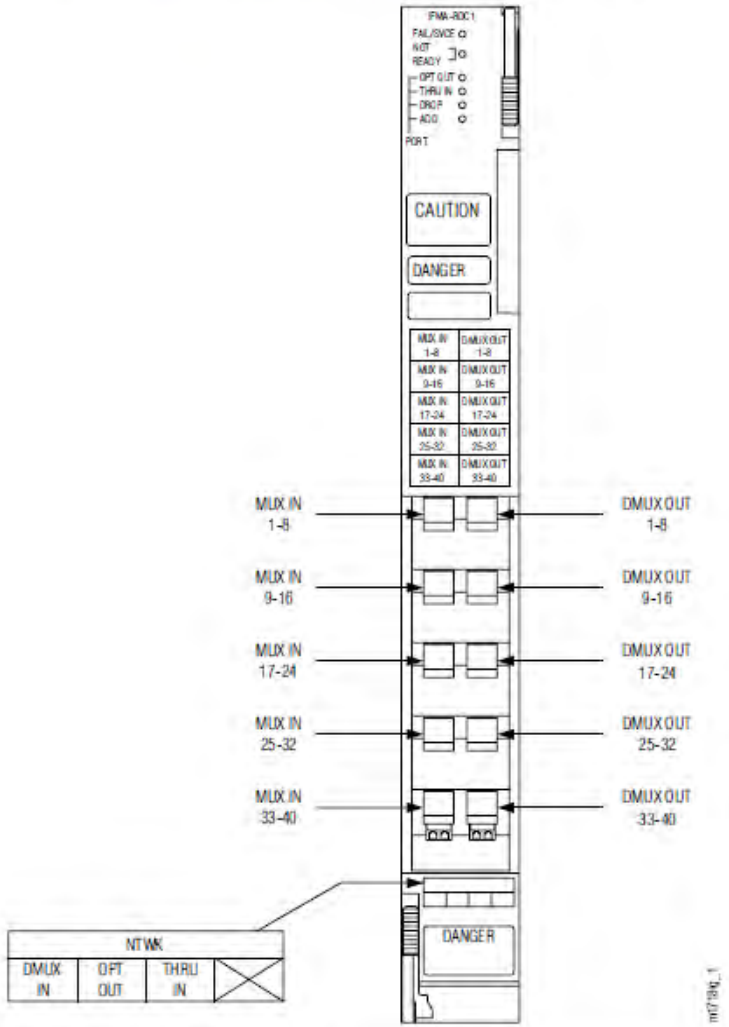


Figure 8-7: 2D-ROADM Unit (SFMA-RDC1) Front Panel and Connector Labels

	According to Fijitsu's Flashwave Unit Description, Fujitsu's "2D-ROADM Unit" has the following features, including separating wavelengths, several input and output channels, and optical channel monitors: **8.4.4 Features** The 2D-ROADM unit (SFMA-RDC1) provides the following features: ▪ Separates a 40-channel multiwavelength optical WDM signal into 40 individual λ channels ▪ Monitors optical levels on 40 individual λ output channels ▪ Monitors optical levels on 40 individual λ input channels ▪ Optically combines 40 individual λ channels into a single WDM signal ▪ Provides firmware download support Fujitsu's Flashwave Unit Description states that Fujitsu's Flashwave ROADMs include wavelength selective switch components and referes to them as "WSS Core Switch Unit." According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)." According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs has the following features:

	9.2.4 Features This unit supports the following features: ▪ Selects up to 40 wavelength channels to produce the multiwavelength signal transmitted by the NE ▪ Blocks unused wavelength channels filtered from the optical inputs ▪ Supports either single wavelength channel, or an multiwavelength signal of up to 40 wavelength channels, on each input port ▪ Provides optical monitoring of all input ports ▪ Performs optical monitoring of the 40 selected output channels on a per-channel basis ▪ Provides optical power level equalization to balance between channels in the output multiwavelength signal ▪ Provides firmware download support (Issue 02 and higher) Fujitsu's Flashwave Unit Description provides the following functional block diagram of Fujitsu's WSS Core Switch Unit in its ROADMs:

Figure 9-2 [p. 9-8] is a functional block diagram of the WSS Core Switch unit.

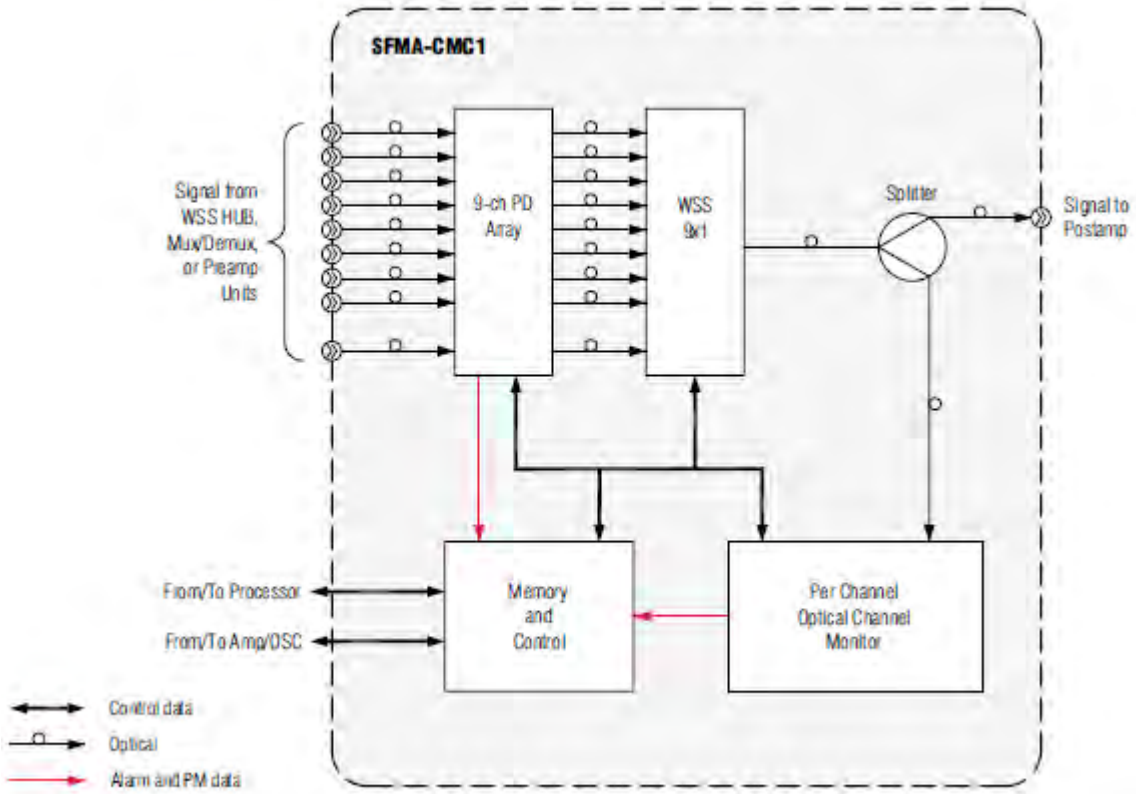


Figure 9-2: WSS Core Switch Unit Functional Block Diagram

According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates according to the following description of the traffic flow through the WSS component:

Traffic Flow

This section describes the traffic flow through the SFMA-CMC1 unit.

Photo Detection

Incoming signals are routed to the photo detection function. The photo detection function monitors the power level of the nine incoming signals and reports information back to the unit control function. This function also performs power balancing so that the signals can be readily combined in the WSS module. If signal power falls below a set level on a given channel, the SFMA-CMC1 unit raises an alarm on that channel.

WSS Module

The optical signals from the photo detection unit are routed to the WSS module. This module combines wavelengths in accordance with user provisioning and blocks any unused wavelengths so that they cannot pass through the unit. The WSS module adjusts individual wavelength channels to balance the output signal using feedback received from the Optical Channel Monitor function.

Optical Channel Monitor

The outgoing multiwavelength signal is split with one version routed to the Optical Channel Monitor function. This function monitors the optical power on each of the 40 individual wavelength channels in the outgoing signal. Information on channel power is used to make adjustments in the WSS module so that the outgoing signal is optimized for transmission to the postamp unit.

Optical Transmission

The combined WDM signal is transmitted though a shuttered LC connector on the unit front panel. From there it is connected into the postamp traffic flow through the Amplifier unit (APMA-xxC1/U1) for transmission into the network.

Memory and Control

The WSS Core Switch unit (SFMA-CMC1) performs memory and control functions for filtering optical wavelengths from the input signals. The WSS Core Switch provides monitoring and power balancing to control wavelength channels passing through the unit. The unit also provides performance monitoring and alarm and provisioning tasks. The unit communicates with other units and with the NE Management (NEM) Shelf Processor unit (MPMA) through a backplane interface.

Synchronization

Synchronization is not required because this unit is completely optical. The WSS Core Switch unit (SFMA-CMC1) performs wavelength selection, blocking, and combination optically, without the use of pointer bytes or other timing mechanisms.

WSS Core Switch Unit Optical Traffic Detection Points

This subsection describes the WSS Core Switch unit (SFMA-CMC1) optical detection points used to report optical alarms and performance measurements for the WDM and WCH facilities and associated ports.

	According to Fujitsu's Flashwave Unit Description, the following figure shows how traffic passes through Fujitsu's WSS Core Switch Unit as follows:

Figure 9-3 [p. 9-10] shows the photo detectors used to generate optical PM and alarm information for the traffic passing through the WSS Core Switch unit.

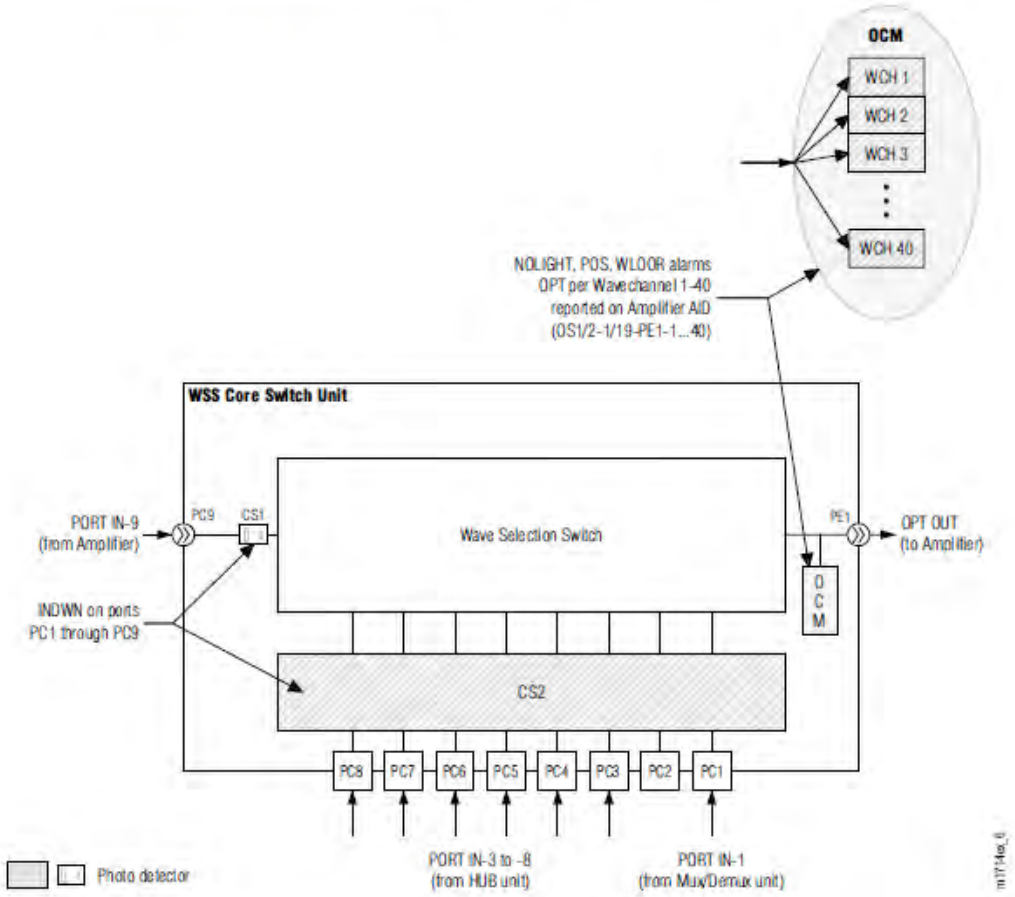


Figure 9-3: WSS Core Switch Unit Optical Traffic Detection Points

Note: *The optical channel monitor (OCM) module in the WSS Core Switch unit provides optical readings for each wavelength channel. These readings are used to report alarms and PM measurements that are reported on the Amplifier unit (APMA-xxC1/U1).*

an input port for an input multi-wavelength optical signal having first spectral channels;	Fujitsu's ROADMs include an input port for an input multi-wavelength optical signal having first spectral channels. According to Fijitsu's Flashwave Unit Description, Fujitsu sells a "2D-ROADM Unit" depicted in the figure below, which shows the input and output ports in the ROADM unit:

Figure 8-7 [p. 8-25] shows the 2D-ROADM plug-in unit (SFMA-RDC1) front panel.

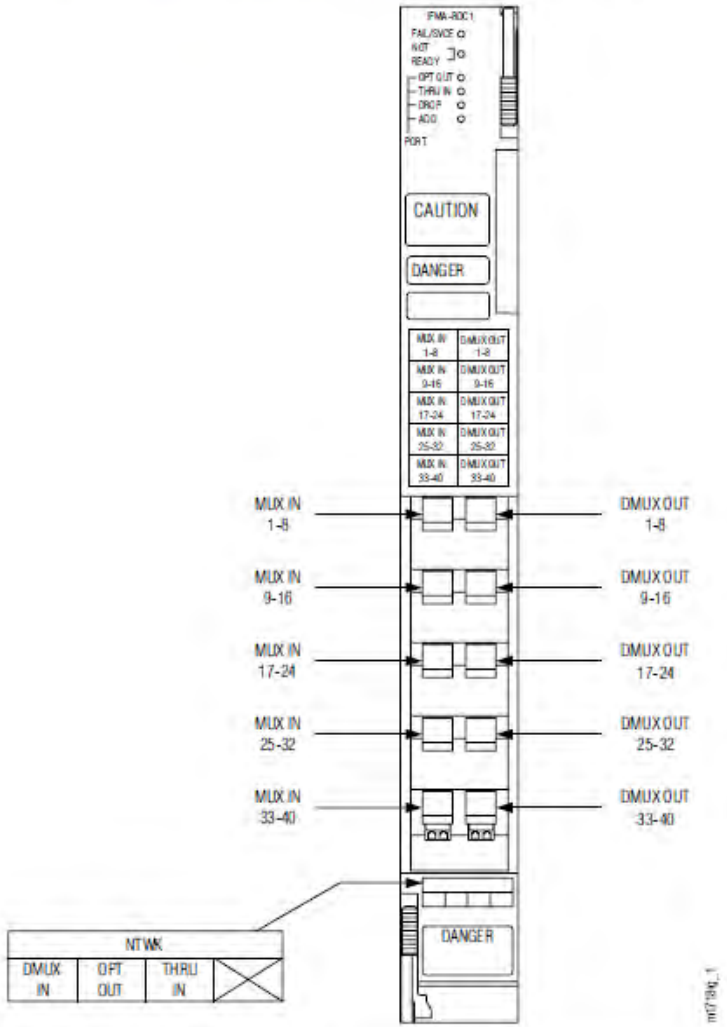


Figure 8-7: 2D-ROADM Unit (SFMA-RDC1) Front Panel and Connector Labels

	According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked."
one or more other ports for second spectral channels;	Fujitsu's ROADMs include one or more other ports for second spectral channels. According to Fijitsu's Flashwave Unit Description, Fujitsu sells a "2D-ROADM Unit" depicted in the figure below, which shows the ports in the ROADM unit:

Figure 8-7 [p. 8-25] shows the 2D-ROADM plug-in unit (SFMA-RDC1) front panel.

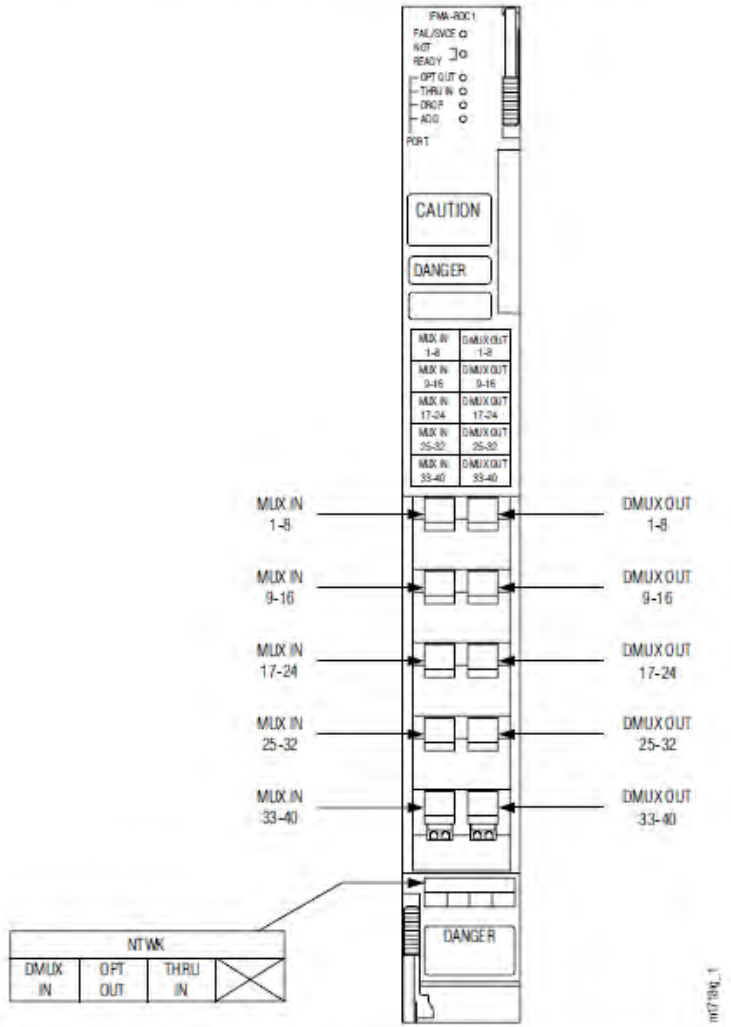


Figure 8-7: 2D-ROADM Unit (SFMA-RDC1) Front Panel and Connector Labels

	According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs has one or more other ports for second spectral channels as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked."
an output port for an output multi-wavelength optical signal;	Fujitsu's ROADMs include an output port for an output multi-wavelength optical signal. According to Fijitsu's Flashwave Unit Description, Fujitsu sells a "2D-ROADM Unit" depicted in the figure below, which shows the ports in the ROADM unit:

Figure 8-7 [p. 8-25] shows the 2D-ROADM plug-in unit (SFMA-RDC1) front panel.

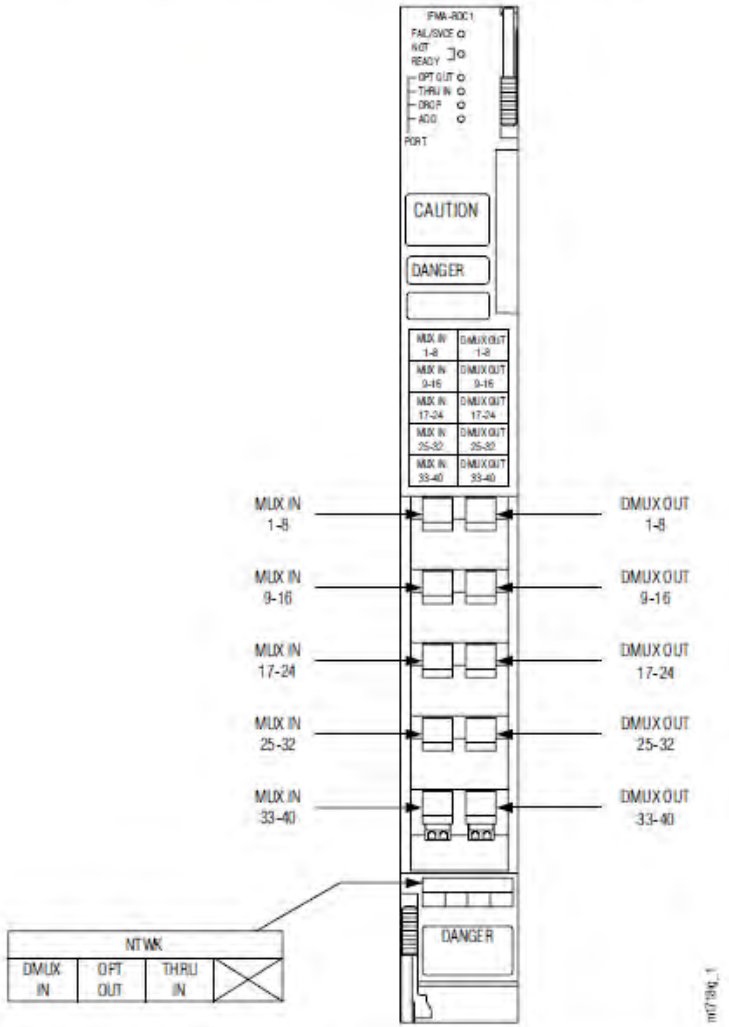
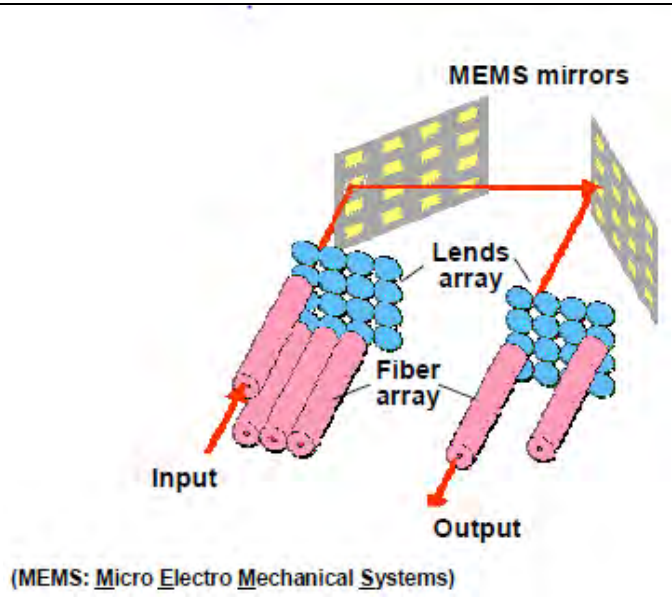


Figure 8-7: 2D-ROADM Unit (SFMA-RDC1) Front Panel and Connector Labels

	According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs has an output port for an output multi-wavelength optical signal as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked."
a wavelength-selective device for spatially separating said spectral channels;	The Fujitsu ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS-based switching module. The switching module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Fijitsu's Flashwave Unit Description, Fujitsu's "2D-ROADM Unit" "separates a 40-channel multiwavelength optical WDM signal into 40 individual wavelength channels." It achieves this wavelength separation using a wavelength-separator, aka a diffraction grating: **8.4.4 Features** The 2D-ROADM unit (SFMA-RDC1) provides the following features: ▪ Separates a 40-channel multiwavelength optical WDM signal into 40 individual λ channels ▪ Monitors optical levels on 40 individual λ output channels ▪ Monitors optical levels on 40 individual λ input channels ▪ Optically combines 40 individual λ channels into a single WDM signal ▪ Provides firmware download support

a spatial array of beam -deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.	The Fujitsu ROADMs include a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS-based switching module. The switching module includes a spatial array of beam -deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Fujitsu's Website, the switching module (the WSS Core Switch Unit) in Fujitsu's ROADMs uses micro-electromechanical mirrors ("MEMS" or "micromirrors") as the switching engine component within the switching module. Each MEMs mirror receives one wavelength (or spectral channel). The MEMs mirrors are beam-deflecting elements. The MEMs mirrors are individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port as follows: "Advanced Wavelength Selective Switch: The optical core of this Dense Wavelength Division Multiplexing (DWDM) platform is based on an advanced Wavelength Selective Switch (WSS). This delivers the most flexible wavelength routing and topology available today. The platform enables optical mesh architectures, with which metro and regional carriers are shaping the DWDM transport network of the future. It also integrates optical multiplexer/demultiplexer, variable optical attenuation and a Micro Electrical Mechanical System (MEMS)-based optical switch into a single component. The WSS removes the need for fiber jumpers when adding or dropping wavelengths. Overall, the capabilities of the FLASHWAVE 7500 system allow drastic reductions in both CAPEX and OPEX." According to Fujitsu's Powerpoint, the switching module (the WSS Core Switch Unit) in Fujitsu's ROADMs use micro-electromechanical mirrors ("MEMS" or "micromirrors") as the switching engine component within the switching module as follows:



(MEMS: Micro Electro Mechanical Systems)

According to Fujitsu's Flashwave Paper, Fujitsu's WSS uses beam deflecting elements as follows: "Through traffic enters a WSS element, and wavelengths that were dropped and should not continue are blocked from the output fiber. The mirrors in a WSS position wavelengths passing through the node to the output fiber. Other wavelengths are added via transponder cards through add-port fibers on the WSS and are also directed to the output fiber. In this way, through traffic and add traffic are multiplexed together and then amplified and output from the node.

According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs switches (or routes) and attentuates wavelengths as follows:

"The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission

	through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)." According to Fujitsu's Website, Fujitsu describes the functionality of its ROADMs, which include WSSs, as follows: "The keys to any ROADM are the optical switch fabric and optical switching technology. Fujitsu employs an advanced Wavelength Selective Switch (WSS) module as our optical switching "engine." The WSS provides wavelength selection, switching, power monitoring, and auto-power balancing all within a single device. In addition, the WSS allows Fujitsu ROADMS to support advanced network architectures such as multidegree hub nodes and mesh architectures." According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)."
2. The optical add-drop	The Fujitsu ROADMs described in claim 1 further include a control unit for controlling each of said beam-

apparatus of claim 1 further comprising a control unit for controlling each of said beam-deflecting elements.	deflecting elements. According to Fujitsu's Flashwave Datasheet and Fujitsu's Flashwave Datasheet 2, Fujitsu's ROADM functions include: "• Automatic level and gain control (No manual attenuation) • Per-channel optical channel monitoring" According to Fijitsu's Flashwave Unit Description, Fujitsu's "2D-ROADM Unit" has the following features, including separating wavelengths, several input and output channels, and optical channel monitors: **8.4.4 Features** The 2D-ROADM unit (SFMA-RDC1) provides the following features: ▪ Separates a 40-channel multiwavelength optical WDM signal into 40 individual λ channels ▪ Monitors optical levels on 40 individual λ output channels ▪ Monitors optical levels on 40 individual λ input channels ▪ Optically combines 40 individual λ channels into a single WDM signal ▪ Provides firmware download support According to Fujitsu's Flashwave Unit Description, Fujitsu's ROADMs include a servo-control assembly as follows: ***Optical Channel Monitor*** The outgoing multiwavelength signal is split with one version routed to the Optical Channel Monitor function. This function monitors the optical power on each of the 40 individual wavelength channels in the outgoing signal. Information on channel power is used to make adjustments in the WSS module so that the outgoing signal is optimized for transmission to the postamp unit.
7. The optical add-drop	The ROADMs described in claim 1 further include alignment mirrors for adjusting alignment of said input

apparatus of claim 1 further comprising alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.	and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device. According to Fujitsu's Specifications, Fujitsu's ROADMs use at least a MEMs WSS. The WSS include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.
8. The optical add-drop apparatus of claim 7 further comprising collimators associated with said alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.	The ROADMs described in claim 7 further comprise collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators. According to Fujitsu's Specifications, Fujitsu's ROADMs use at least a MEMs WSS. The WSS include collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.
13. The optical add-drop apparatus of claim 1, wherein said beam-deflecting elements comprise micromachined mirrors.	The beam deflecting elements of the ROADMs described in claim 1 comprise micromachined mirrors. According to Fujitsu's Specifications, the ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include micromachined mirrors.

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Claim 12 of U.S. Patent No. RE42,678
v.
Fujitsu Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. A wavelength-separating-routing apparatus, comprising:	Fujitsu makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Fujitsu's ROADM products, including: • "Flashwave 9500 Packet Optical Networking Platform," from Fujitsu Network Communictions Inc., dated July 2010, available from us.fujitsu.com/telecom ("Flashwave Datasheet"); • "Flashwave 9500 Packet Optical Networking Platform," from Fujitsu Network Communictions Inc., dated March 2014, available from www.fujitsu.com/downloads/TEL/fnc/datasheets/flashwave9500.pdf ("Flashwave Datasheet 2") • "Optical Components and Devices for Next-Generation Photonic Networks," by M. Kawai, K. Mori, T. Yamamoto, O. Tsuboi, K. Tanaka, K. Morito, I. Sawaki, and M. Suguwara, dated July 10, 2006, published in Fujitsu Sci. Tech. J. 42.4, pp. 483-93 (October 2006); • "Fujitsu's Third-Generation Optical Transport Solution for Metro Optical Networks: Flashwave 7500," by H. Matsumoto, H. Iino, S. Carlton, dated April 10, 2006, published in Fujitsu Sci. Tech. J. 42.4, pp. 460-68 (October 2006) ("Flashwave Paper"); • "Unit Descriptions, Flashwave 7500, Release 5.2, Issue 1, April 2008," from Fujitsu Network Communications Inc., dated April 2008 ("Flashwave Unit Description"); • "Optical Burst Switches," by T. Yamamoto, from Fujitsu Limited and Fujitsu Laboratories Limited, dated 2006 ("Fujitsu Powerpoint"); • "Fujitsu Powered Video on Demand Solutions," from Fujitsu Network Commmunications Inc., dated 2005 ("VOD Paper"); and • Information and documents available from Fujitsu's website (www.fujitsu.com), specifically the pages describing Fujitsu's Flashwave 7500 (www.fujitsu.com/us/services/telecom/products/flashwave-7500.html) and Fujitsu's Flashwave 9500 (www.fujitsu.com/us/services/telecom/products/flashwave-9500.html) ("Website") (collectively, the "Fujitsu ROADM Materials").

	According to Fujitsu's Flashwave Paper: "Fujitsu has chosen a device called a wavelength selectable switch (WSS) as the core of its next generation products. This device improves on the switch fabric in second-generation systems. The WSS performs the traditional switching and also performs channel power balancing and can switch traffic between multiple rings. This device enables new network configurations such as hubs and meshes, which gives network planners a high degree of flexibility. "Another dramatic new development in optical communications is the use of lasers that can be tuned across the full range of wavelengths, allowing users to dynamically reconfigure wavelengths within a system. The WSS has the unique ability to allow any input port to accept or drop any wavelength (each port in a typical second-generation system is dedicated to a specific wavelength). When full-band tunable lasers are used with the WSS, a line card can operate at any wavelength. This greatly improves the time to market for new services and simplifies network planning. Fujitsu has coined the term "dynamic optical add-drop multiplexer (DOADM) to describe this configuration. [Note – a "DOADM" is equivalent to a "ROADM."]." "[A] WSS element can drop wavelengths to any of multiple paths. If all the wavelengths cannot be supported by a single WSS card, more WSS cards can be daisy chained to further separate the wavelengths until each one exist a single fiber. The advantage of using WSSs is that any wavelength can be directed to any output fiber. This mode of operation is called colorless because output ports are not associated with a particular wavelength or color. ... "Through traffic enters a WSS element, and wavelengths that were dropped and should not continue are blocked from the output fiber. The mirrors in a WSS position wavelengths passing through the node to the output fiber. Other wavelengths are added via transponder cards through add-port fibers on the WSS and are also directed to the output fiber. In this way, through traffic and add traffic are multiplexed together and then amplified and output from the node." According to Fujitsu's Flashwave Paper, the following diagram depicts the operation of Fujitsu's Flashwave ROADM (aka DOADM) devices:

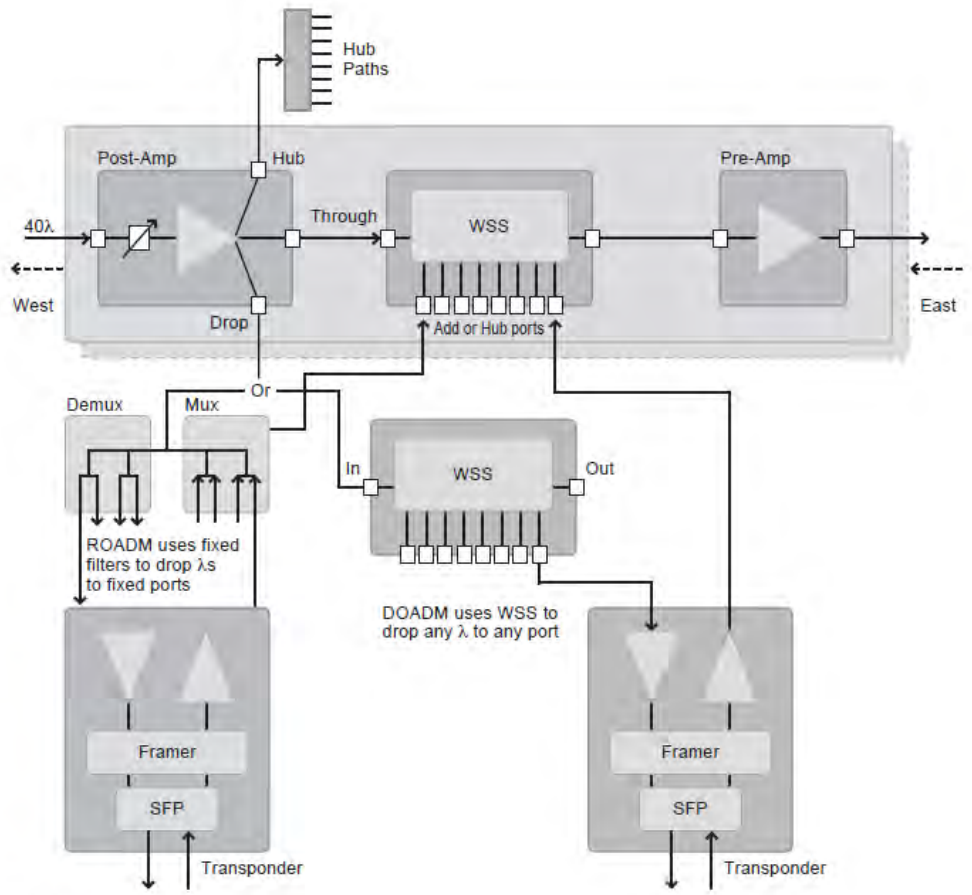


Figure 3
FLASHWAVE architecture.

(Flashwave Paper, Figure 3, p. 465)

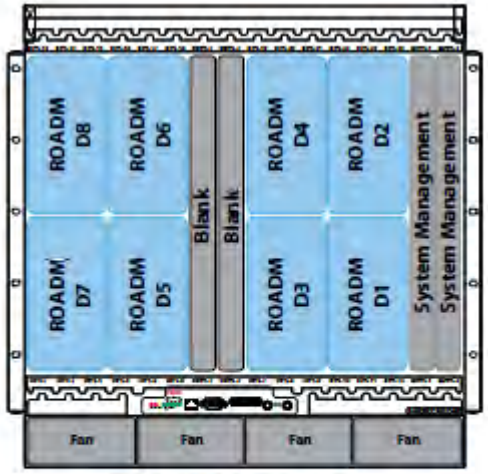
According to Fujitsu's Website, Fujitsu describes the functionality of its ROADMs, which include WSSs, as follows:

	"FLASHWAVE 7500 Metro/Regional Multiservice ROADM: The FLASHWAVE 7500 optical transport system is the global superhighway for flexible high bandwidth service delivery. It offers the most advanced DWDM, Optical hubbing, ROADM, and network design capabilities to deliver and manage growing metro and regional networks. The system supports both ANSI and ETSI-certified solutions, along with different configurations to optimize your metro and regional network infrastructures. • DWDM Optical Hubbing • 10 Gbps and 40 Gbps fully tunable DWDM wavelengths • G.709 OTN interfaces, including MSPP-on-a-card • Advanced functions for operational simplification • Complete network automation from design to management "Advanced Wavelength Selective Switch: The optical core of this Dense Wavelength Division Multiplexing (DWDM) platform is based on an advanced Wavelength Selective Switch (WSS). This delivers the most flexible wavelength routing and topology available today. The platform enables optical mesh architectures, with which metro and regional carriers are shaping the DWDM transport network of the future. It also integrates optical multiplexer/demultiplexer, variable optical attenuation and a Micro Electrical Mechanical System (MEMS)-based optical switch into a single component. The WSS removes the need for fiber jumpers when adding or dropping wavelengths. Overall, the capabilities of the FLASHWAVE 7500 system allow drastic reductions in both CAPEX and OPEX. "Flexible, Modular Architecture: The FLASHWAVE 7500 Metro/Regional Multiservice ROADM is an economical and sophisticated solution for today's metro and regional bandwidth requirements for up to 40 wavelengths, 24 nodes and 1000 km in distance. Remote software provisioning and sophisticated self-tuning features allow rapid service activation. Advanced optical line cards provide efficient on-ramps to a fully photonic backbone, delivering key business services such as Video on Demand (VoD), residential high-speed Internet access and enterprise data services across metro and regional networks up to 1000 kilometers. "Over the past seven years, WDM networks have evolved from simple point-to-point systems to single-ring networks to advanced interconnected mesh architectures. Reconfigurable Optical Add/Drop Multiplexers (ROADMs) are the key network element enabling these advanced networks, along with a key technology component called a Wavelength Selective Switch (WSS)."

	"Fujitsu was the first vendor to develop and deploy ROADM technology in 2003, and the first to incorporate a WSS-based optical switch fabric. Fujitsu remains the global industry leader in metro/regional ROADM technology and solutions. "Prior to ROADMs, DWDM systems were commonly implemented using "fixed filters" in what is known as a "banded" DWDM architecture. A typical banded DWDM system provided 32 channels in eight groups of four channels in each group. Banded DWDM systems, like the Fujitsu FLASHWAVE 7420, remain popular for many access WDM and price-sensitive applications. ROADMS offer additional size, flexibility, and performance benefits, including: • Improved network utilization due to single-channel granularity • Non-block access to any lambda – improved network efficiency • Flexibility & service velocity – drop any channel and any number of channels at any site • Integrated auto-power balancing, eliminating costly & timely manual tuning • Full band tunable transponders • Support for interconnected ring and mesh architectures • A-Z end-to-end wavelength provisioning "The keys to any ROADM are the optical switch fabric and optical switching technology. Fujitsu employs an advanced Wavelength Selective Switch (WSS) module as our optical switching "engine." The WSS provides wavelength selection, switching, power monitoring, and auto-power balancing all within a single device. In addition, the WSS allows Fujitsu ROADMS to support advanced network architectures such as multidegree hub nodes and mesh architectures." According to Fujitsu's Website, Fujitsu's Flashwave 9500 product contains a ROADM: "The FLASHWAVE 9500 is the definitive Packet ONP. Its unique hardware and software architecture integrates Ethernet, ROADM and SONET/SDH technology in a single shelf that drives cost out of today's metro network. As high-bandwidth, high-quality multimedia packet-centric services dominate, service providers can deploy the FLASHWAVE 9500 platform to enjoy the cost and manageability that optical networking has always provided.

	"The FLASHWAVE 9500 Packet ONP solution family is designed to consist of common interface cards and system software across a variety of configurations, traffic capacity ranges, and entry prices allowing service providers to cost-optimize their network. • Purpose-built modular design • Fujitsu patent-pending universal TDM/Packet fabric • MPLS-based connection-oriented Ethernet transport technology to deliver private-line quality Ethernet aggregation and connectivity services • Integrated ROADM technology to deliver bulk bandwidth economically and with operational simplicity • Next-generation SONET/SDH technology to support the full range of network services while retaining operational continuity with existing networks • High density multiservice, multirate TDM interfaces • A full 40G-ready ROADM in one-quarter of a shelf • 480G of SONET/SDH or packet bandwidth in only one-third of a rack" According to Fujitsu's Flashwave Datasheet, Fujitsu's ROADM functions include: • "High-density 8-degree ROADM configuration in a single 13 RU shelf • 8-degree x 88-channel Wavelength Selectable Switch (WSS) • Operator-selectable ITU-T wavelengths support 50 GHz ITU-T grid • ROADM full-band tunable interface units o 10G universal transponder o 40G transponder o 8-port multirate muxponder • 10G/40G wavelength support – 100G ready • Automatic level and gain control (No manual attenuation) • Per-channel optical channel monitoring • Operator-tunable dispersion compensation • Narrowband direct connect • SONET SDCC and OTN GCC support • OCh-DPRING optical protection • Operator-configurable Forward Error Correction options (FEC or EFEC)"

According to Fujitsu's Flashwave Datasheet, Fujitsu's Flashwave products incorporate ROADMs as follows:



ROADM Configuration
8-degree – 88-channel ROADM
Multishelf support for service interfaces
10G/40G wavelength support
100G hardware ready

(Flashwave Datasheet, p. 7)

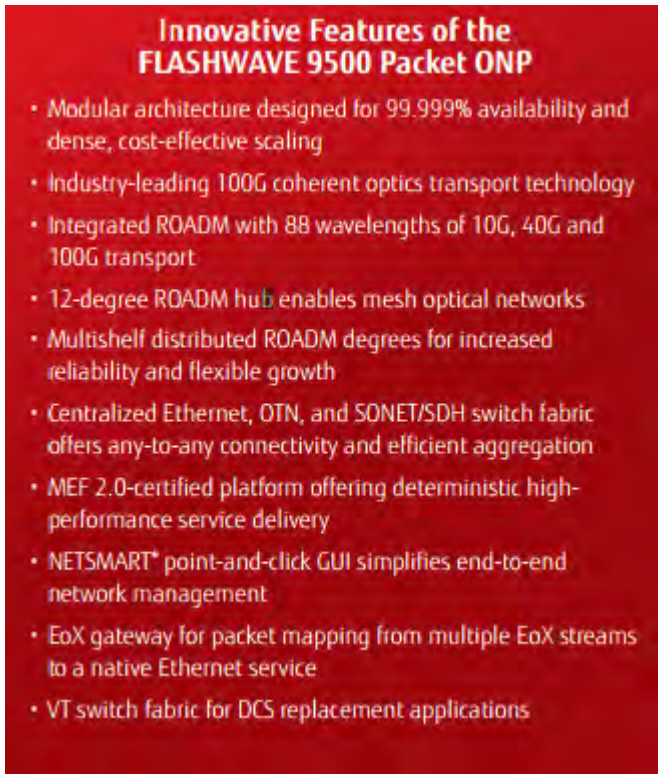
According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave products include a ROADM:

"The FLASHWAVE 9500 Packet ONP delivers ROADM, OTN, Ethernet and TDM technologies for deploying optical ring, mesh, and linear add/drop topologies with 99.999% service availability. All plug-in cards, fans and chassis power distribution are designed for resilient operation with no single point of failure. The modular architecture enables carriers to select configurations for specific applications, whether ROADM-only, aggregation-only, or combinations of service aggregation and WDM on a single network element. The

	FLASHWAVE 9500 system reduces footprint, capital/operational expenses, and complexity by collapsing multiple technologies and network layers into a single, easy-to-use, modular platform." "High-Density 88-Channel Pluggable ROADM: The 88-channel pluggable ROADM provides per-channel add/drop capability. This offers flexibility and capacity scaling that enables service providers to address metro, regional and core networks now and into the future. The central switch fabric optimizes the ROADM technology through sub-wavelength grooming and aggregation. The flexibility of the ROADM allows a mix of services transported over 10G, 40G, 100G and future 400G rates onto any of the 88 channels. The FLASHWAVE 9500 system offers up to a 12-degree optical multi-TID hub for mesh network wavelength mapping. This higher density optical hub increases network interconnect capability while reducing transponder requirements through direct WSS interconnect between collocated network elements." "System Capacity • 960 Gbps non-blocking SONET/SDH grooming • 1.2 Tbps non-blocking packet grooming • 2.4 Tbps OTN switch fabric w/ODU0, 1, 2, 2e, 3, 4 and ODU flex grooming • 20 Gbps non-blocking VT grooming • Up to 8 degrees of ROADM connectivity • 88 x 10 Gbps/40 Gbps/100 Gbps wavelengths per ROADM degree • Universal interface slots o SDS shelf: 16 o HDS shelf: 24" "ROADM Functions: • Asymetric multi-TID 12-degree hub • High-density 8-degree ROADM configuration in a single shelf or distributed across multiple shelves (split-hub ROADM) • 8-degree x 88-channel Wavelength Selectable Switch (WSS) • Operator-selectable ITU-T wavelengths support 50 GHz ITU-T grid • ROADM full-band tunable interface units o 10G universal transponder o 40G transponder o 12-port multirate muxponder

- 100G transponder/muxponder
- 10G/40G/100G wavelength support
- Per-channel optical channel monitoring
- Narrowband direct connect
- SONET SDCC and OTN GCC support
- OCh-DPRING optical protection

According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave product is a ROADM:



(Flashwave Datasheet 2, p. 2)

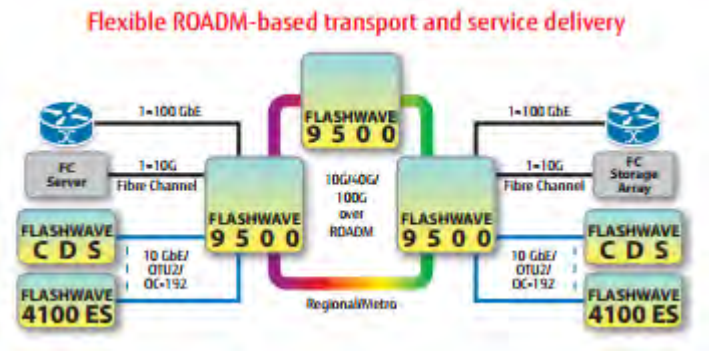
	According to Fujitsu's Flashwave Datasheet 2, Fujitsu's Flashwave products provide ROADM-based transport and service delivery:  (Flashwave Datasheet 2, p. 2) According to Fijitsu's Flashwave Unit Description, Fujitsu sells a "2D-ROADM Unit" depicted in the figure below, which shows the input and output ports in the ROADM unit:

Figure 8-7 [p. 8-25] shows the 2D-ROADM plug-in unit (SFMA-RDC1) front panel.

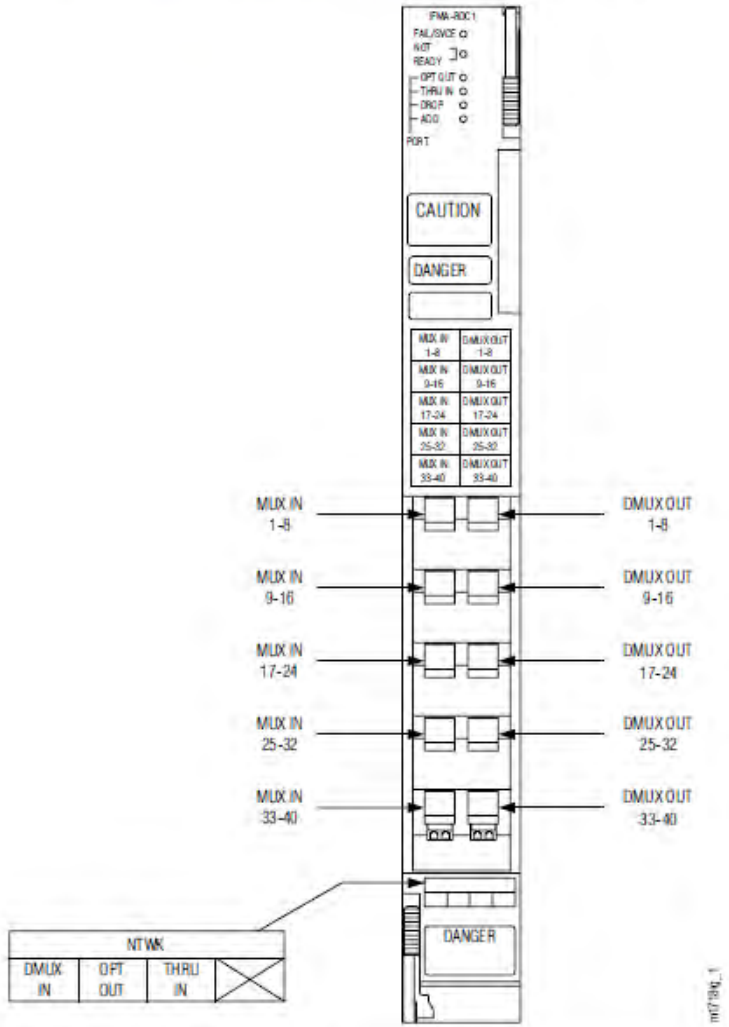


Figure 8-7: 2D-ROADM Unit (SFMA-RDC1) Front Panel and Connector Labels

	According to Fijitsu's Flashwave Unit Description, Fujitsu's "2D-ROADM Unit" has the following features, including separating wavelengths, several input and output channels, and optical channel monitors: **8.4.4 Features** The 2D-ROADM unit (SFMA-RDC1) provides the following features: ▪ Separates a 40-channel multiwavelength optical WDM signal into 40 individual λ channels ▪ Monitors optical levels on 40 individual λ output channels ▪ Monitors optical levels on 40 individual λ input channels ▪ Optically combines 40 individual λ channels into a single WDM signal ▪ Provides firmware download support Fujitsu's Flashwave Unit Description states that Fujitsu's Flashwave ROADMs include wavelength selective switch components and referes to them as "WSS Core Switch Unit." According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)."

	According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs has the following features: **9.2.4 Features** This unit supports the following features: ▪ Selects up to 40 wavelength channels to produce the multiwavelength signal transmitted by the NE ▪ Blocks unused wavelength channels filtered from the optical inputs ▪ Supports either single wavelength channel, or an multiwavelength signal of up to 40 wavelength channels, on each input port ▪ Provides optical monitoring of all input ports ▪ Performs optical monitoring of the 40 selected output channels on a per-channel basis ▪ Provides optical power level equalization to balance between channels in the output multiwavelength signal ▪ Provides firmware download support (Issue 02 and higher) Fujitsu's Flashwave Unit Description provides the following functional block diagram of Fujitsu's WSS Core Switch Unit in its ROADMs:

Figure 9-2 [p. 9-8] is a functional block diagram of the WSS Core Switch unit.

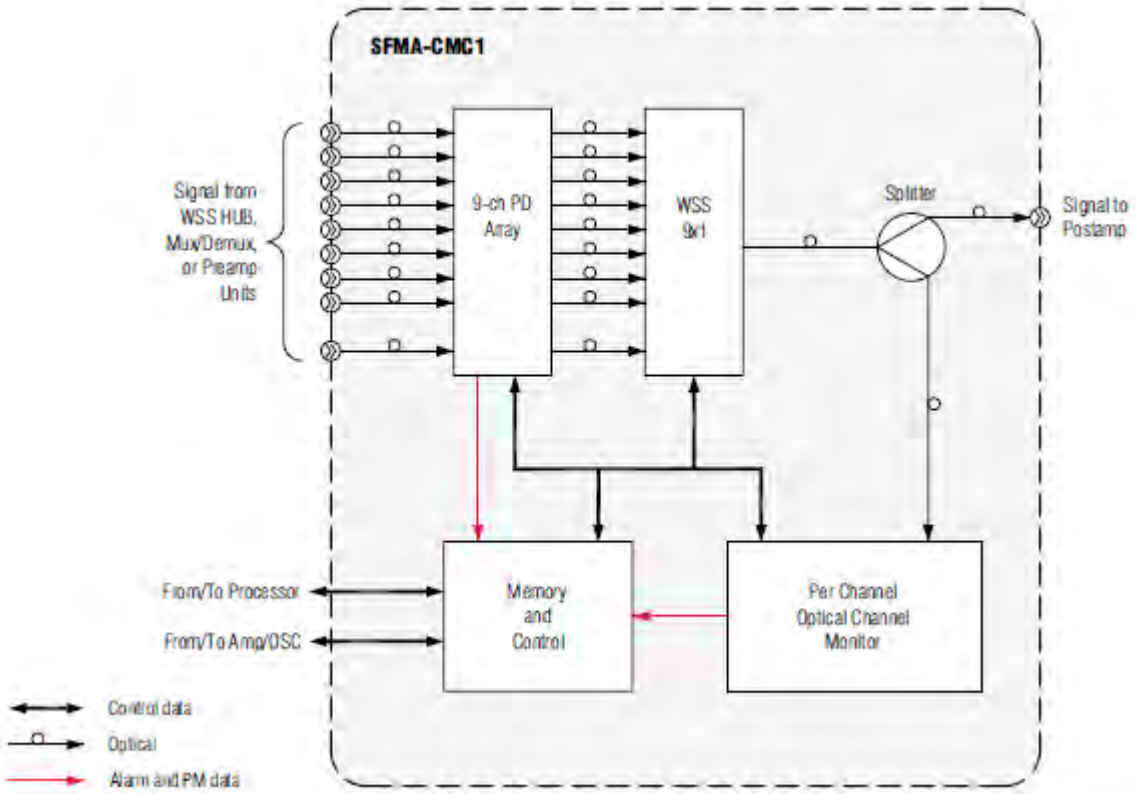


Figure 9-2: WSS Core Switch Unit Functional Block Diagram

According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates according to the following description of the traffic flow through the WSS component:

Traffic Flow

This section describes the traffic flow through the SFMA-CMC1 unit.

Photo Detection

Incoming signals are routed to the photo detection function. The photo detection function monitors the power level of the nine incoming signals and reports information back to the unit control function. This function also performs power balancing so that the signals can be readily combined in the WSS module. If signal power falls below a set level on a given channel, the SFMA-CMC1 unit raises an alarm on that channel.

WSS Module

The optical signals from the photo detection unit are routed to the WSS module. This module combines wavelengths in accordance with user provisioning and blocks any unused wavelengths so that they cannot pass through the unit. The WSS module adjusts individual wavelength channels to balance the output signal using feedback received from the Optical Channel Monitor function.

Optical Channel Monitor

The outgoing multiwavelength signal is split with one version routed to the Optical Channel Monitor function. This function monitors the optical power on each of the 40 individual wavelength channels in the outgoing signal. Information on channel power is used to make adjustments in the WSS module so that the outgoing signal is optimized for transmission to the postamp unit.

Optical Transmission

The combined WDM signal is transmitted though a shuttered LC connector on the unit front panel. From there it is connected into the postamp traffic flow through the Amplifier unit (APMA-xxC1/U1) for transmission into the network.

Memory and Control

The WSS Core Switch unit (SFMA-CMC1) performs memory and control functions for filtering optical wavelengths from the input signals. The WSS Core Switch provides monitoring and power balancing to control wavelength channels passing through the unit. The unit also provides performance monitoring and alarm and provisioning tasks. The unit communicates with other units and with the NE Management (NEM) Shelf Processor unit (MPMA) through a backplane interface.

Synchronization

Synchronization is not required because this unit is completely optical. The WSS Core Switch unit (SFMA-CMC1) performs wavelength selection, blocking, and combination optically, without the use of pointer bytes or other timing mechanisms.

WSS Core Switch Unit Optical Traffic Detection Points

This subsection describes the WSS Core Switch unit (SFMA-CMC1) optical detection points used to report optical alarms and performance measurements for the WDM and WCH facilities and associated ports.

	According to Fujitsu's Flashwave Unit Description, the following figure shows how traffic passes through Fujitsu's WSS Core Switch Unit as follows:

Figure 9-3 [p. 9-10] shows the photo detectors used to generate optical PM and alarm information for the traffic passing through the WSS Core Switch unit.

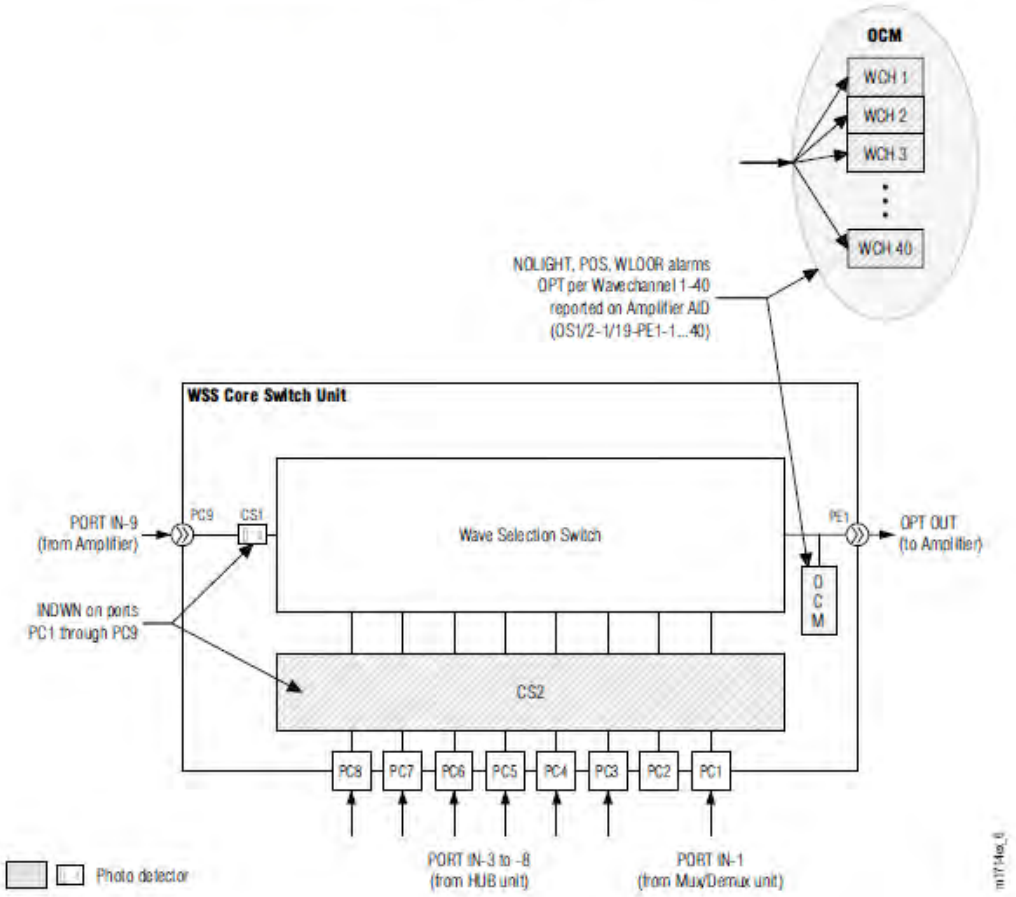
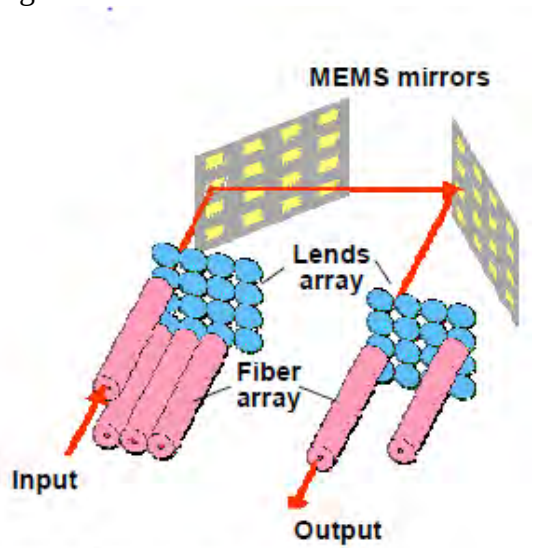


Figure 9-3: WSS Core Switch Unit Optical Traffic Detection Points

Note: *The optical channel monitor (OCM) module in the WSS Core Switch unit provides optical readings for each wavelength channel. These readings are used to report alarms and PM measurements that are reported on the Amplifier unit (APMA-xxC1/U1).*

a) multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports;	The Fujitsu ROADMs include multiple fiber collimators, providing an input port for a multi -wavelength optical signal and a plurality of output ports. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS switching component (a "switching module" or "WSS device" or "WSS Core Switch Unit"). The switching module includes multiple fiber collimators, providing an input for multi-wavelength optical signal and a plurality of output ports.
b) a wavelength-separator, for separating said multi-wavelength optical signal from said input port into multiple spectral channels;	The Fujitsu ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS-based switching module. The switching module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Fijitsu's Flashwave Unit Description, Fujitsu's "2D-ROADM Unit" "separates a 40-channel multiwavelength optical WDM signal into 40 individual wavelength channels." It achieves this wavelength separation using a wavelength-separator, aka a diffraction grating: **8.4.4 Features** The 2D-ROADM unit (SFMA-RDC1) provides the following features: ▪ Separates a 40-channel multiwavelength optical WDM signal into 40 individual λ channels ▪ Monitors optical levels on 40 individual λ output channels ▪ Monitors optical levels on 40 individual λ input channels ▪ Optically combines 40 individual λ channels into a single WDM signal ▪ Provides firmware download support

c) a beam-focuser, for focusing said spectral channels into corresponding spectral spots; and	The Fujitsu ROADMs include a beam-focuser, for focusing said spectral channels into corresponding spectral spots. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS-based switching module. The switching module includes a beam-focuser, for focusing said spectral channels into corresponding spectral spots.
d) a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports.	The Fujitsu ROADMs include a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Fujitsu's ROADM Materials, Fujitsu's ROADM products include a WSS-based switching module. The switching module includes a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. According to Fujitsu's Website, the switching module (the WSS Core Switch Unit) in Fujitsu's ROADMs use micro-electromechanical mirrors ("MEMS" or "micromirrors") as the switching engine component within the switching module as follows: "Advanced Wavelength Selective Switch: The optical core of this Dense Wavelength Division Multiplexing (DWDM) platform is based on an advanced Wavelength Selective Switch (WSS). This delivers the most flexible wavelength routing and topology available today. The platform enables optical mesh architectures, with which metro and regional carriers are shaping the DWDM transport network of the future. It also integrates optical multiplexer/demultiplexer, variable optical attenuation and a Micro Electrical Mechanical System (MEMS)-based optical switch into a single component. The WSS removes the need for fiber jumpers when adding or dropping wavelengths. Overall, the capabilities of the FLASHWAVE 7500 system allow drastic reductions in both CAPEX and OPEX."

	According to Fujitsu's Powerpoint, the switching module (the WSS Core Switch Unit) in Fujitsu's ROADMs use micro-electromechanical mirrors ("MEMS" or "micromirrors") as the switching engine component within the switching module as follows:  (MEMS: Micro Electro Mechanical Systems) According to Fujitsu's Flashwave Paper, Fujitsu's WSS uses mirrors as follows: "Through traffic enters a WSS element, and wavelengths that were dropped and should not continue are blocked from the output fiber. The mirrors in a WSS position wavelengths passing through the node to the output fiber. Other wavelengths are added via transponder cards through add-port fibers on the WSS and are also directed to the output fiber. In this way, through traffic and add traffic are multiplexed together and then amplified and output from the node. According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs switches (or routes) and attentuates wavelengths as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input

	ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)." According to Fujitsu's Website, Fujitsu describes the functionality of its ROADMs, which include WSSs, as follows: "The keys to any ROADM are the optical switch fabric and optical switching technology. Fujitsu employs an advanced Wavelength Selective Switch (WSS) module as our optical switching "engine." The WSS provides wavelength selection, switching, power monitoring, and auto-power balancing all within a single device. In addition, the WSS allows Fujitsu ROADMS to support advanced network architectures such as multidegree hub nodes and mesh architectures." According to Fujitsu's Flashwave Unit Description, Fujitsu's WSS Core Switch Unit in its ROADMs operates as follows: "The WSS Core Switch unit provides nine optical input ports and one optical output port. Each optical input port can serve an individual wavelength or a multiwavelength optical signal of up to forty channels. One optical input port receives the WDM signal from the preamplifier to manage through traffic, and the other eight optical input ports handle either individual wavelengths, or multiwavelength signals. The WSS Core Switch receives these signals from a WSS HUB Switch unit (hub applications only), or a Mux/Demux unit. Any wavelength launched into any of the nine optical input ports can be selected for transmission through the optical output port. Individual wavelengths received through input ports are either selected to pass through the unit, or blocked. "The WSS Core Switch provides individual variable optical attenuation (VOA) for each selected wavelength. In addition, the VOA function equalizes all wavelengths so that each individual wavelength enters the postamp with the same fixed power. The VOA also provides preemphasis functionality (for example, to counteract amplifier tilt of a succeeding in-line amplifier)."

12. The wavelength-separating-routing apparatus of claim 1 wherein each channel micro-mirror is a silicon micromachined mirror.	The channel micromirrors of the ROADMs described in claim 1 are silicon micromachined mirrors. Fujitsu ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include silicon micromachined mirrors.

Claims 7, 8 and 13 of U.S. Patent No. RE42,368
v.
Tellabs Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. An optical add-drop apparatus comprising:	Tellabs makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Tellabs's ROADM products, including: • "DATASHEET: Tellabs® 7100 Optical Transport System: Fully Integrated Transport and Services Delivery Platform" from Tellabs, dated 2010 ("Datasheet"); • "PRODUCT OVERVEIW: Tellabs Packet-Optical Transport: The Tellabs 7100 series is an integrated intelligent Ethernet, SONET/SDH, OTN and ROADM-based DWDM," from Tellabs, dated 2011 ("Product Overview"); • "WHITE PAPER: Tellabs® Optical Enterprise Solution: Bringing Cost-Effective, Secure and Reliable, High-Bandwidth and Energy-Efficient Optical Networking to Federal Agencies," from Tellabs, dated 2009 ("White Paper"); and • information and documents available from Tellabs's website (tellabs.com) ("Website") (collectively, ROADM Materials"). According to Tellabs's Datasheet: "The Tellabs 7100 OTS features an integrated dynamic optical core and intelligent services interfaces that together deliver Add/Drop Multiplexer (ADM) capability or Layer 2 packet switching on a single blade. Dynamic optical networking enables you to meet today's network needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree Reconfigurable Optical ADM (ROADM) and optical switching technologies. ... "Features that Deliver Immediate and Future Benefits: Increased Network Flexibility and Service Delivery: The Tellabs 7100 OTS overcomes the shortcomings of point-to-point Wavelength Division Multiplexer (DWDM) systems by introducing a multi-degree ROADM architecture based on Wavelength Selective Switching (WSS) technology. This architecture simplifies network engineering, solves the stranded

	capacity issues that can occur as a result of channel banding and eliminates re-engineering to accommodate moves and changes." "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously. According to Tellabs's Product Overview: "The use of ROADMs in the network eliminates the need for unnecessary electronics at every site throughout the network. ... "The Tellabs 7100 OTS uses intelligent services modules that deliver MSPP capability, native Ethernet switching and OXC capabilities. ... "The Tellabs 7100 OTS enables service providers to meet today's bandwidth needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree ROADM. In addition, the control plane is based on Automatic Switched Optical Network/Generalized Multiprotocol Label Switching (ASON/GMPLS), providing accurate network resource inventory and robust mesh restoration. ... "The Tellabs® 7100 Nano™ Optical Transport System is a smaller version of the flagship Tellabs 7100 OTS that offers even more flexibility, efficiency and cost-effectiveness. It provides critical ROADM features available with the Tellabs 7100 OTS — with the size, density, low power requirements and capabilities that make it an ideal solution at the network edge and enterprise customer locations. "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color. "The Tellabs 7100 Nano OTS is a self-sufficient, standalone system designed for quick and easy installation. Like the Tellabs 7100 OTS, it supports 10 Gbps and 40 Gbps, enabling a four-fold bandwidth increase in capacity with minimal capital and operational investment. ...

	"Pluggable optics, software programmable service ports and multi-degree Wavelength Selective Switch (WSS)-based ROADM modules stop unnecessary truck rolls. ... "Multi-degree ROADM architecture gives service providers the ability to provision lightpaths where needed to deliver services and easily respond to unexpected demand in the network." "The switching module also incorporates a passive wavelength combiner that can add or multiplex optical signals from up to nine tributary ports into an aggregate signal. "Network reconfiguration using the switching module allows flexible, remote provisioning of any demand, and simplifies network planning by safeguarding upgrade capacity and extending network life—resulting in operational and capital savings and faster revenue capture." According to Tellabs's White Paper: "Optical Networking with WSS ROADM: "Wavelength activation with older DWDM systems was complex, expensive, and slow. Activating a wavelength required complex planning followed by a truck roll to every node in the wavelength's path to add transponders, balance, and tune the network. This resulted in high capital and operating expenses, while the time required to deploy and activate additional bandwidth was measured in weeks. This manual process also increased the potential for error and decreased reliability. ROADM enables wavelengths to be passed through and dropped or added remotely without new hardware and without a truck roll, reducing costs and speeding service activation. "Today's third-generation ROADMs, including the Tellabs 7100 OTS, employ WSS. Now considered the technology of choice for carriers worldwide, WSS ROADM brings more flexibility and lower total cost of ownership to various network scenarios. WSS ROADM allows operators to route any wavelength, or any combination of wavelengths, to any node without the need to predefine traffic demands or install additional devices, thereby reducing the time to deploy new services. "WSS ROADMs enable the operator to select and then re-select the specific wavelength to add/drop at the node, which is particularly beneficial when traffic is difficult to predict or if it is expected to change often. WSS ROADMS can also be deployed not only in rings and chains, as in previous generations, but in multi-ring and mesh topologies common in metro core and regional WDM networks. The Tellabs 7100 OTS adds

	the ability to provide automatic power balancing, so when agencies insert a new node into an existing network, the network automatically reengineers power levels appropriately." According to Tellabs's Website: "The Tellabs® 7100 Optical Transport Series ... offer[s] [p]rogrammable ROADM technology at the optical layer." Press releases state that Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.
an input port for an input multi-wavelength optical signal having first spectral channels;	Tellabs's ROADMs include an input port for an input multi-wavelength optical signal having first spectral channels. According to Tellabs's Datasheet, Tellabs' ROADM necessarily includes an input port for an input multi-wavelength optical signal having first spectral channels as follows: "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously." According to Tellabs's Product Overview, Tellabs' ROADM necessarily includes an input port for an input multi-wavelength optical signal having first spectral channels as follows: "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color."
one or more other ports for second spectral channels;	Tellabs's ROADMs include one or more other ports for second spectral channels. As shown in Tellabs's ROADM Materials, Tellabs's ROADMs include a WSS-based switching module. The switching module includes one or more other ports for second spectral channels as follows: "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any

	combination, and can support 10G and 40G wavelengths simultaneously." "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color."
an output port for an output multi-wavelength optical signal;	Tellabs's ROADMs include an output port for an output multi-wavelength optical signal. According to Tellabs's Datasheet, Tellabs' ROADM necessarily includes an output port for an output multi-wavelength optical signal as follows: "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously." According to Tellabs's Product Overview, Tellabs' ROADM necessarily includes an output port for an output multi-wavelength optical signal as follows: "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color."
a wavelength-selective device for spatially separating said spectral channels;	The Tellabs ROADMs include a wavelength-selective device for spatially separating said spectral channels. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a wavelength-selective device for spatially separating said spectral channels.
a spatial array of beam - deflecting elements positioned such that each element receives a corresponding one of said spectral channels,	The Tellabs ROADMs include a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching

each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port.	module. The switching module includes a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels, each of said elements being individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports and to control the power of the spectral channel reflected to said selected port. According to Tellabs's White Paper: "The Tellabs 7100 OTS adds the ability to provide automatic power balancing, so when agencies insert a new node into an existing network, the network automatically reengineers power levels appropriately." Press releases state that Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.
7. The optical add-drop apparatus of claim 1 further comprising alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.	The ROADMs described in claim 1 further include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device. According to Tellabs's Specifications, Tellabs's ROADMs use at least a MEMs WSS. The WSS include alignment mirrors for adjusting alignment of said input and output multi-wavelength optical signals and said second spectral channels with said wavelength-selective device.
8. The optical add-drop apparatus of claim 7 further comprising collimators associated with said alignment mirrors, and imaging lenses in a telecentric arrangement with said	The ROADMs described in claim 7 further comprise collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators. According to Tellabs's Specifications, Tellabs's ROADMs use at least a MEMs WSS. The WSS include collimators associated with the alignment mirrors, and imaging lenses in a telecentric arrangement with said alignment mirrors and said collimators.

alignment mirrors and said collimators.	
13. The optical add-drop apparatus of claim 1, wherein said beam-deflecting elements comprise micromachined mirrors.	The beam deflecting elements of the ROADMs described in claim 1 comprise micromachined mirrors. According to Tellabs's Specifications, Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include micromachined mirrors.

Claim 12 of U.S. Patent No. RE42,678
v.
Tellabs Reconfigurable Optical Add Drop Multiplexers ("ROADM") Accused Instrumentalities

Claim	Product Analysis
1. A wavelength-separating-routing apparatus, comprising:	Tellabs makes, uses, sells, imports, and/or offers to sell reconfigurable optical add drop multiplexers ("ROADMs") and other products that incorporate wavelength selective switches ("WSSs"), each of which is a wavelength separating-routing apparatus. Several documents detail the functionality of Tellabs's ROADM products, including: • "DATASHEET: Tellabs® 7100 Optical Transport System: Fully Integrated Transport and Services Delivery Platform" from Tellabs, dated 2010 ("Datasheet"); • "PRODUCT OVERVEIW: Tellabs Packet-Optical Transport: The Tellabs 7100 series is an integrated intelligent Ethernet, SONET/SDH, OTN and ROADM-based DWDM," from Tellabs, dated 2011 ("Product Overview"); • "WHITE PAPER: Tellabs® Optical Enterprise Solution: Bringing Cost-Effective, Secure and Reliable, High-Bandwidth and Energy-Efficient Optical Networking to Federal Agencies," from Tellabs, dated 2009 ("White Paper"); and • information and documents available from Tellabs's website (tellabs.com) ("Website") (collectively, ROADM Materials"). According to Tellabs's Datasheet: "The Tellabs 7100 OTS features an integrated dynamic optical core and intelligent services interfaces that together deliver Add/Drop Multiplexer (ADM) capability or Layer 2 packet switching on a single blade. Dynamic optical networking enables you to meet today's network needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree Reconfigurable Optical ADM (ROADM) and optical switching technologies. ... "Features that Deliver Immediate and Future Benefits: Increased Network Flexibility and Service Delivery: The Tellabs 7100 OTS overcomes the shortcomings of point-to-point Wavelength Division Multiplexer (DWDM) systems by introducing a multi-degree ROADM architecture based on Wavelength Selective Switching (WSS) technology. This architecture simplifies network engineering, solves the stranded capacity

	issues that can occur as a result of channel banding and eliminates re-engineering to accommodate moves and changes." "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously. According to Tellabs's Product Overview: "The use of ROADMs in the network eliminates the need for unnecessary electronics at every site throughout the network. ... "The Tellabs 7100 OTS uses intelligent services modules that deliver MSPP capability, native Ethernet switching and OXC capabilities. ... "The Tellabs 7100 OTS enables service providers to meet today's bandwidth needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree ROADM. In addition, the control plane is based on Automatic Switched Optical Network/Generalized Multiprotocol Label Switching (ASON/GMPLS), providing accurate network resource inventory and robust mesh restoration. ... "The Tellabs® 7100 Nano™ Optical Transport System is a smaller version of the flagship Tellabs 7100 OTS that offers even more flexibility, efficiency and cost-effectiveness. It provides critical ROADM features available with the Tellabs 7100 OTS — with the size, density, low power requirements and capabilities that make it an ideal solution at the network edge and enterprise customer locations. "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color. "The Tellabs 7100 Nano OTS is a self-sufficient, standalone system designed for quick and easy installation. Like the Tellabs 7100 OTS, it supports 10 Gbps and 40 Gbps, enabling a four-fold bandwidth increase in capacity with minimal capital and operational investment. ...

	"Pluggable optics, software programmable service ports and multi-degree Wavelength Selective Switch (WSS)-based ROADM modules stop unnecessary truck rolls. ... "Multi-degree ROADM architecture gives service providers the ability to provision lightpaths where needed to deliver services and easily respond to unexpected demand in the network." "The switching module also incorporates a passive wavelength combiner that can add or multiplex optical signals from up to nine tributary ports into an aggregate signal. "Network reconfiguration using the switching module allows flexible, remote provisioning of any demand, and simplifies network planning by safeguarding upgrade capacity and extending network life—resulting in operational and capital savings and faster revenue capture." According to Tellabs's White Paper: "Optical Networking with WSS ROADM: "Wavelength activation with older DWDM systems was complex, expensive, and slow. Activating a wavelength required complex planning followed by a truck roll to every node in the wavelength's path to add transponders, balance, and tune the network. This resulted in high capital and operating expenses, while the time required to deploy and activate additional bandwidth was measured in weeks. This manual process also increased the potential for error and decreased reliability. ROADM enables wavelengths to be passed through and dropped or added remotely without new hardware and without a truck roll, reducing costs and speeding service activation. "Today's third-generation ROADMs, including the Tellabs 7100 OTS, employ WSS. Now considered the technology of choice for carriers worldwide, WSS ROADM brings more flexibility and lower total cost of ownership to various network scenarios. WSS ROADM allows operators to route any wavelength, or any combination of wavelengths, to any node without the need to predefine traffic demands or install additional devices, thereby reducing the time to deploy new services. "WSS ROADMs enable the operator to select and then re-select the specific wavelength to add/drop at the node, which is particularly beneficial when traffic is difficult to predict or if it is expected to change often. WSS ROADMS can also be deployed not only in rings and chains, as in previous generations, but in multi-ring and mesh topologies common in metro core and regional WDM networks. The Tellabs 7100 OTS adds the ability to provide automatic power balancing, so when agencies insert a new node into an existing network, the network

	automatically reengineers power levels appropriately." According to Tellabs's Website: "The Tellabs® 7100 Optical Transport Series ... offer[s] [p]rogrammable ROADM technology at the optical layer." Press releases state that Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.
a) multiple fiber collimators, providing an input port for a multi-wavelength optical signal and a plurality of output ports;	The Tellabs ROADMs include multiple fiber collimators, providing an input port for a multi -wavelength optical signal and a plurality of output ports. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module ("switching module"). The switching module includes multiple fiber collimators, providing an input for multi-wavelength optical signal and a plurality of output ports.
b) a wavelength-separator, for separating said multi-wavelength optical signal from said input port into multiple spectral channels;	The Tellabs ROADMs include a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a wavelength separator, for separating multi-wavelength optical signal from said input port into multiple spectral channels.
c) a beam-focuser, for focusing said spectral channels into corresponding spectral spots; and	The Tellabs ROADMs include a beam-focuser, for focusing said spectral channels into corresponding spectral spots. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a beam-focuser, for focusing said spectral channels into corresponding spectral spots.
d) a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral	The Tellabs ROADMs include a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into

channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports.	said output ports. According to Tellabs's ROADM Materials, Tellabs's ROADM products include a WSS-based switching module. The switching module includes a spatial array of channel micromirrors positioned such that each channel micromirror receives one of said spectral channels, said channel micromirrors being pivotal about two axes and being individually and continuously controllable to reflect said corresponding received spectral channels into any selected ones of said output ports and to control the power of said received spectral channels coupled into said output ports. Press releases state that Tellabs's ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs.
2. The wavelength-separating-routing apparatus of claim 1 further comprising a servo-control assembly, in communication with said channel micromirrors and said output ports, for providing control of said channel micromirrors and thereby maintaining a predetermined coupling of each reflected spectral channel into one of said output ports.	The Tellabs ROADMs described in claim 1 further include a servo-control assembly, in communication with said channel micromirrors and said output ports, for providing control of said channel micromirrors and thereby maintaining a predetermined coupling of each reflected spectral channel into one of said output ports. According to Tellabs's Datasheet: "The Tellabs 7100 OTS features an integrated dynamic optical core and intelligent services interfaces that together deliver Add/Drop Multiplexer (ADM) capability or Layer 2 packet switching on a single blade. Dynamic optical networking enables you to meet today's network needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree Reconfigurable Optical ADM (ROADM) and optical switching technologies. ... "Features that Deliver Immediate and Future Benefits: Increased Network Flexibility and Service Delivery: The Tellabs 7100 OTS overcomes the shortcomings of point-to-point Wavelength Division Multiplexer (DWDM) systems by introducing a multi-degree ROADM architecture based on Wavelength Selective Switching (WSS) technology. This architecture simplifies network engineering, solves the stranded capacity issues that can occur as a result of channel banding and eliminates re-engineering to accommodate moves and changes." "The nine-port, Wavelength Selectable Switch (WSS)-based switching module performs the primary multi-degree optical switching functionality at each ROADM node. Each switching module contains a WSS capable of dynamically adding, dropping, or expressing any of 44 wavelengths to any of nine ports, in any combination, and can support 10G and 40G wavelengths simultaneously.

	According to Tellabs's Product Overview: "The use of ROADMs in the network eliminates the need for unnecessary electronics at every site throughout the network. ... "The Tellabs 7100 OTS enables service providers to meet today's bandwidth needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree ROADM. In addition, the control plane is based on Automatic Switched Optical Network/Generalized Multiprotocol Label Switching (ASON/GMPLS), providing accurate network resource inventory and robust mesh restoration. ... "Like the Tellabs 7100 OTS, the Tellabs 7100 Nano OTS supports 88 wavelengths. The Tellabs 7100 Nano OTS can add or drop any number of wavelengths. Using the same service delivery modules as the Tellabs 7100 OTS, wavelengths added or dropped from the Tellabs 7100 Nano OTS can be of any color. "Pluggable optics, software programmable service ports and multi-degree Wavelength Selective Switch (WSS)-based ROADM modules stop unnecessary truck rolls. ... "Network reconfiguration using the switching module allows flexible, remote provisioning of any demand, and simplifies network planning by safeguarding upgrade capacity and extending network life—resulting in operational and capital savings and faster revenue capture." According to Tellabs's Website: "The Tellabs® 7100 Optical Transport Series ... offer[s] [p]rogrammable ROADM technology at the optical layer."
12. The wavelength-separating-routing apparatus of claim 1 wherein each channel micro-mirror is a silicon micromachined mirror.	The channel micromirrors of the ROADMs described in claim 1 are silicon micromachined mirrors. Tellabs ROADMs use at least a MEMs mirror array in the WSSs of the ROADMs. The WSS include silicon micromachined mirrors.